

## Rules (2-4 players)

### Reference Energy System: The Game

This innovative board game offers students a hands-on approach to understanding reference energy system models, preparing them for using energy modelling tools like OSEMOSYS. Players strategically construct power plants, manage resources, and balance energy production, mirroring real-world energy system challenges. The game teaches critical concepts such as grid stability, technology efficiency, and the trade-offs between clean and dirty energy sources. By incorporating elements like carbon tax and renewable energy subsidies, it also introduces students to policy considerations in energy planning.

**Aim of the game:** To produce the most energy units (achieved by constructing a complete horizontal line from resource creation to demand)

#### Set up:

- Provide each player (2-4) with a board: a 'Reference Energy System'
- Place all the energy tiles face down in the middle of the table
- (The dice are used later in the scoring phase)

#### Gameplay

1. **Choose your Tiles.** Each player collects 7 face down tiles from the centre of the table – this will form your 'hand'.
2. **Play Your Tiles.** From the 7 tiles in your hand choose two to place on your board and place them face up in the correct positions. (If you legally cannot, or choose not to, place them in the 'spare tile box' for 'gamble' or points later)
3. **Pass your remaining tiles left.** Once all players have done step 2, give the tiles you did not choose to the player on your left. You will therefore receive a hand of tiles from your neighbour. These tiles will make up your new hand of tiles for the next turn. You will have two fewer tiles each turn, and on your last turn, you will only have two to choose from.
4. **Trade.** On the last turn you will only have 1 tile. You may trade with another person's last tile before placing it on the board.

Before continuing make sure all players have 7 tiles on the board.

#### Redo the same loop:

5. **Choose your Tiles again.** Collect another 7 tiles from the centre of the table.
6. **Play Your Tiles.** From the 7 tiles in your hand choose two to place on your board and place them face up in the correct positions. (If you legally cannot - or choose not to - place one or both of your tiles on the board in a correct position, place them in the 'spare tile box' for 'gamble' later)
7. **Pass your remaining tiles to the right.** Once all players have done step 2, give the tiles you did not choose to the player on your left. You will therefore receive a hand of tiles from your neighbour. These tiles will make up your new hand of tiles for the next turn.

You will have two fewer tiles each turn, and on your last turn, you will only have two to choose from.

- 8. Trade.** On the last turn you will only have 1 tile. You may trade with another person's last tile before placing it on the board.

Before continuing each player should have no more 14 tiles on their board.

#### Redo the same loop a final time:

- 9. Choose your Tiles again.** Collect another 7 tiles from the centre of the table.
- 10. Play Your Tiles.** From the 7 tiles in your hand choose two to place on your board and place them face up in the correct positions. (If you legally cannot, or choose not to, place one or both of your tiles on the board in a correct position, place them in the 'spare tile box' for 'gamble' later)
- 11. Pass your remaining tiles to the left.** Once all players have done step 2, give the tiles you did not choose to the player on your left. You will therefore receive a hand of tiles from your neighbour. These tiles will make up your new hand of tiles for the next turn. You will have two fewer tiles each turn, and on your last turn, you will only have two to choose from.
- 12. Trade.** On the last turn you will only have 1 tile. You may trade with another person's last tile before placing it on your board.

#### Final steps

- 13. Check.** Players should only have 21 tiles on their board.
- 14. Gamble.** In a 4-player game, each player may swap up to 4 'unused' tiles they have in the centre (In a 3-player game they may swap up to 5; in a 2-player game, swap up to 6.)
- 15. Optimize.** Adjust your tiles on the board to maximise points- Remember only complete horizontal lines score points

#### Scoring

Scoring occurs in four stages:

- 1. Energy points produced:** Each 'complete' horizontal line / powerplant created earns energy points depending on the power plant used:

Natural Gas: 7 Dirty, 3 Clean Energy

Coal Power: 9 Dirty Energy

Hydro Power: 7 Clean Energy

Wind Power: 4 Clean Energy

Solar Power: 2 Clean Energy

Biofuel: 3 Clean Energy

Hydrogen: 4 Clean Energy

Nuclear: 8 Clean, 1 dirty

Any Unused Tiles: 1 Dirty Energy per 2 tiles

## 2. Award Bonus Energy Points:

A.

Technology Efficiency Bonus: If a player has more than one of the same type of a complete power plant, they get a multiplier of that energy unit for each additional plant of that type. For example- two wind power plants would generate 4 *additional* clean energy points (2x2), three wind power would equal 9 (3x3) additional clean energy points. Fossil fuel powerplants work similar but only award dirty energy points.

B.

Grid Stability Level 1: If a player has at least one of each type of power plant (fossil and renewable), they get a bonus of 2 clean energy units and 2 dirty energy units

Grid Stability Level 2: If a player has 3 different types of power plant one of which must be a fossil fuel, they get an additional bonus of 3 clean energy units and 3 dirty energy units

Grid Stability Level 3: If a player has 4 different types of power plant one of which must be fossil fuel, they get an additional bonus of 6 clean energy units and 6 dirty energy units

Grid Stability Level 4: If a player has 5 different types of power plant one of which must be fossil fuel, they get an additional bonus of 15 clean energy units and 15 dirty energy units

Grid Stability Level 5: If a player has 6 different types of power plant one of which must be fossil fuel, they get an additional bonus of 35 clean energy units and 35 dirty energy units

## 3. Carbon Tax

The youngest player now rolls two dice to dictate the *carbon tax* for the game – the ‘end game penalty’. Whatever is rolled, that is how many *dirty energy units* are removed from each player's score

## 4. Renewable Energy Subsidy

For every four Clean Energy points produced, gain an extra Clean Energy point.

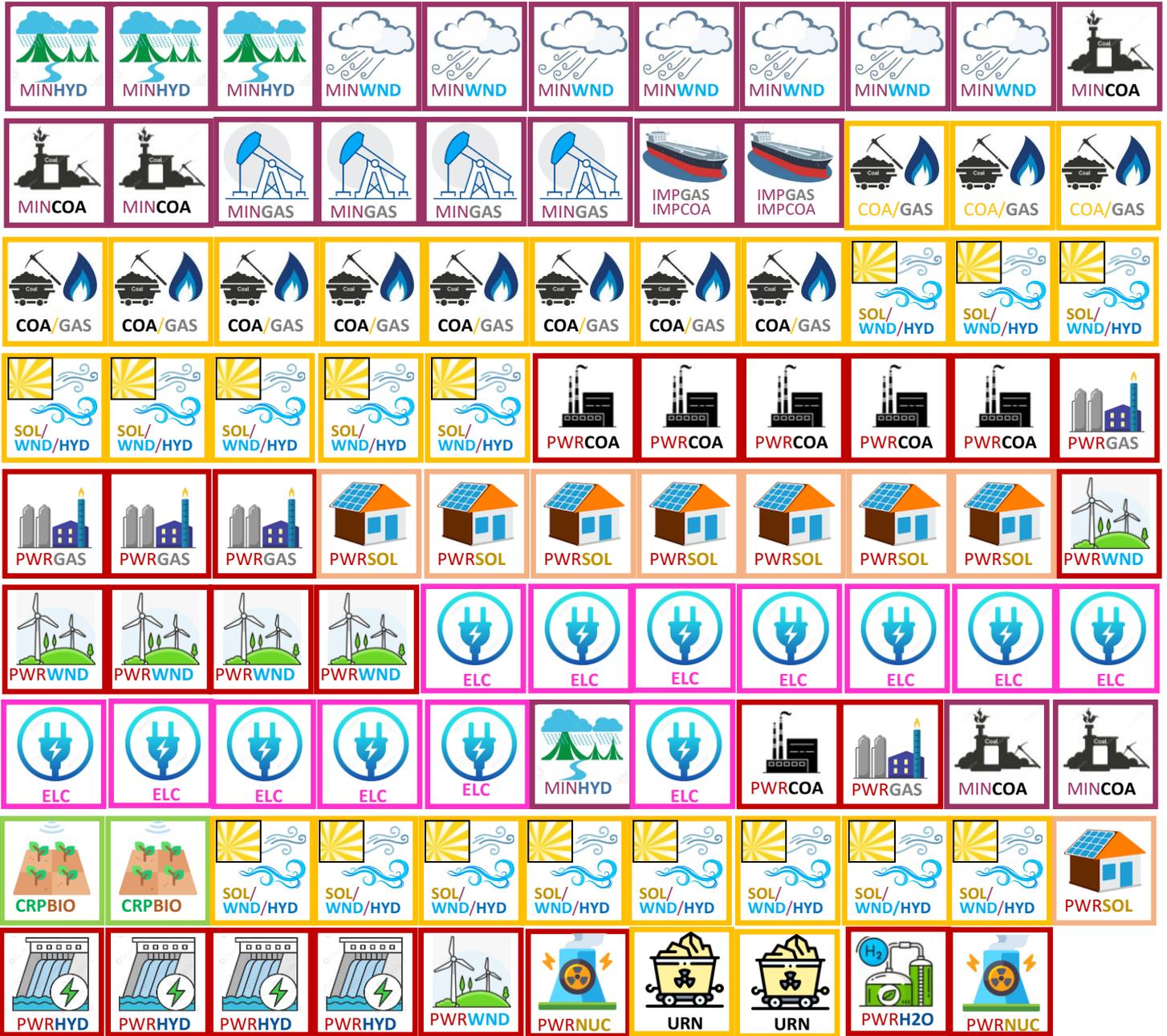
## Declaring a Winner

Whoever has the most (Dirty+Clean) energy points is the winner – if there is a tie, the player with the most clean energy points win's!

## Components

Technology Type	Name	Amount
Resource Tech	MINSOL	0
	MINHYD	4
	MINWND	7
	MINCOA	5
	MINGAS	4
	IMPGAS/COA	2
Commodities	COA/GAS	11
	SOLHYDWND	16
	ELC	13
Powerplants	PWRCOA	6
	PWRGAS	5
	PWRSOL	8
	PWRHYD	4
	PWRWND	6
Infrastructure	PWRTRN	0
Bonus	URN	2
	CRPBIO	2
	PWRNUC	2
	PWRBIO	0
	PWRH2O	1
<b>TOTAL</b>		<b>98</b>

For printing and cutting



If you want to stick these images on scabble tiles (recommended) resize tile images smaller

**For scoring**

Powerplant / Points	Description	Amount Built	Dirty Points	Clean Points	
Natural Gas	7 Dirty, 3 Clean				
Coal Power	9 Dirty				
Hydro Power	7 Clean				
Wind Power (intermittent)	4 clean				
Solar Power (intermittent)	2 clean				
Bio Power	3 Clean				
Hydrogen power	4 Clean				
Nuclear Power	8 Clean, 1 dirty				
Unused Tiles	1 Dirty Energy per 2 tiles				
Technology Efficiency Bonus	Multiple Powerplants				
Grid Stability Level:	Variety of Powerplants				
<b>TOTAL POINTS</b>	(add up score)				
Carbon Tax	Group Double Dice Roll:		Minus -		
Renewable Energy Subsidy	Divide Clean Point Total by 3			Add:	<b>Dirty + Clean</b>
<b>FINAL TOTAL</b>					

