Debate topic: How clean is your car?

Curriculum:
This resource can be used as an introduction to the topic of fuel cells, alkanes as fuels and biofuels or as a revision tool once the topics have been covered. The resource is suitable to use for AQA, Edexcel, OCR.

Aim:
To understand the advantages and disadvantages of using different energy sources to power cars and the effect they can have on the environment and society.

Objectives:
Consider the pros and cons of using cars that run on biofuels, fossil fuels, electricity and fuel cells.
Argue which source of energy is ‘best’ based on its effects on the environment and society.
Understand that that the disadvantages of using particular energy sources may come from their generation and not their use in cars.

How this resource can be used:

1) Small group debate (50 minutes total):
Starter (5 minutes)
Begin by asking the class about their initial thoughts on the question ‘How clean is your car?’. Encourage the students to think of pros and cons of using cars and write these ideas on the board. Briefly decide which points are more important/relevant than others to come back to later.

Activity (30 minutes):
Divide the class into five groups. Give each group a topic (biofuels, fossil fuels, electric, hybrid and fuel cells) and provide them with the corresponding section provided in the resource. Give the groups 15 minutes to discuss the points given to them on their topic, encourage them to think of their own additional points and to rank each idea in order of importance. Now, one student from each group will join to form a new group. Again give 15 minutes for the mixed groups debate/discuss/defend their ideas on their subject and to decide which points are the most important/relevant.

 Presentations (10 minutes):
Invite one student from each of the mixed groups to present the points their group feel are most important after hearing all the arguments.

Plenary (5 minutes):
Refer back to the pros and cons the class came up with at the beginning of the lesson. Discuss how their opinions towards using cars has changed, if at all. Have their ideas changed with regards to the importance/relevance of their pros and cons list produced at the beginning of the lesson?

2) Whole class debate (50 minutes total):
Starter (5 minutes)
Begin by asking the class about their initial thoughts on the question ‘How clean is your car?’. Encourage the students to think of pros and cons of using cars and write these ideas on the board. Briefly decide which points are more important/relevant than others to come back to later.

Activity (15 minutes):
Divide the class into five groups. Give each group a topic (biofuels, fossil fuels, electric, hybrid and fuel cells) and provide them with the corresponding section provided in the resource. Give the groups 15 minutes to discuss the points given to them on their topic, encourage them to think of their own additional points and to rank each idea in order of importance/relevance.

Presentations (10 minutes):
Invite one/two students from each group (or the whole group), to present their points/ideas to the rest of the class.

Discussion (15 minutes):
After each topic has been presented, the points can be discussed as a whole class (alternatively, the students could return to their groups for the discussion). Encourage the class to debate/discuss each different group of opinions and to come to a conclusion as to which points are most important/relevant.

Plenary (5 minutes):
Refer back to the pros and cons the class came up with at the beginning of the lesson. Discuss how their opinions towards using cars has changed, if at all. Have their ideas changed with regards to the importance/relevance of their pros and cons list produced at the beginning of the lesson?

3) As a circuit activity (50 minutes total):
Starter (5 minutes)
Begin by asking the class about their initial thoughts on the question ‘How clean is your car?’. Encourage the students to think of pros and cons of using cars and write these ideas on the board. Briefly decide which points are more important/relevant than others to come back to later.

Activity (30 minutes):
Set up five areas of the classroom each with its own topic (biofuels, fossil fuels, electric, hybrid and fuel cells). Divide the class into five groups and assign a topic to each group. Give 5-10 minutes for the group to discuss the points given in the resource, encourage them to think of their own additional points. After this time, ask each group to move around the classroom to the next topic and repeat the activity. Repeat until all five topics have been covered.

Discussion (10 minutes):
At the end, bring the class together to discuss their thoughts on using cars. Encourage the class to debate/discuss each different group of opinions and to come to a conclusion as to which points are most important/relevant.

Plenary (5 minutes):
Refer back to the pros and cons the class came up with at the beginning of the lesson. Discuss how their opinions towards using cars has changed, if at all. Have their ideas changed with regards to the importance/relevance of their pros and cons list produced at the beginning of the lesson?

4) Cut and stick (50 minutes total):
Starter (5 minutes)
Begin by asking the class about their initial thoughts on the question ‘How clean is your car?’. Encourage the students to think of pros and cons of using cars and write these ideas on the board. Briefly decide which points are more important/relevant than others to come back to later.

Activity (20 minutes):
Ask the students to work in pairs. Give each pair a paper copy of the resource (five sections covering biofuels, fossil fuels, electric, hybrid and fuel cells) and ask them to cut out each point. Each point should be discussed ranked in order of importance (rather than asking each pair to cover all five topics, assign different pairs different topics).

Presentations (10 minutes):
Invite each pair to state their most important/relevant point and why they have chosen it.

Discussion (10 minutes):
At the end, bring the class together to discuss their thoughts on using cars. Encourage the class to debate/discuss each different group of opinions and to come to a conclusion as to which points are most important/relevant.

Plenary (5 minutes):
Refer back to the pros and cons the class came up with at the beginning of the lesson. Discuss how their opinions towards using cars has changed, if at all. Have their ideas changed with regards to the importance/relevance of their pros and cons list produced at the beginning of the lesson?

Extension:
Before carrying out the activity, ask the students to research all/one of the chosen topics (biofuels, fossil fuels, electric, hybrid and fuel cells) as homework. This will help with developing their own ideas and arguments for debate and the points given resource can be used as a guide.

Questions for reflection:
Have their opinions changed with regards to using biofuels/electricity/fuel cells to power cars instead of fossil fuels?

Which source of energy would they consider using to power cars and why?

How ‘green’ are biofuels and electricity as sources of energy?

Feedback:
We are constantly looking for ways to improve these resources and would be very grateful if the teacher giving the lesson and the students involved with the activity, could provide feedback. The links can be accessed on a computer or a smartphone.

Teacher feedback:
<https://forms.office.com/Pages/ResponsePage.aspx?id=7qe9Z4D970GskTWEGCkKHhIKjMLK9DlHk3LxaBgd4N1UNU5LN1lWSTNBTjlOTUY0TjVDOUM1SkYxRS4u>

Or

<https://bit.ly/2PDG2e3>

Student feedback:
<https://forms.office.com/Pages/ResponsePage.aspx?id=7qe9Z4D970GskTWEGCkKHhIKjMLK9DlHk3LxaBgd4N1UMzJSMU1TVlg3N08zN0c4QTlNTFRGSDBNTy4u>

Or

<https://bit.ly/2UTx39f>

Further information:

[www.ec.europa.eu/energy/en/topics/renewable-energy/biofuels](http://www.ec.europa.eu/energy/en/topics/renewable-energy/biofuels)

[www.greenfacts.org/en/biofuels/l-2/1-definition.htm](http://www.greenfacts.org/en/biofuels/l-2/1-definition.htm)

[www.nextgreencar.com/electric-cars/](http://www.nextgreencar.com/electric-cars/)

[www.fuelcellsystems.co.uk/technology/](http://www.fuelcellsystems.co.uk/technology/)

Research at the University of Nottingham:
Work by Dr Darren Walsh:

* Batteries:

H. Coromina, B. Adeniran, R. Mokaya and D. Walsh, 2016. [Bridging the performance gap between electric double-layer capacitors and batteries with high-energy/high-power carbon nanotube-based electrodes](http://dx.doi.org/10.1039/C6TA05686E) J. Mater. Chem. A. 4, 14586-14594.

Batteries and electric double-layer capacitors (EDLCs) are two of the most promising systems to store energy from renewable energy sources such as wind turbines and solar panels. A new system of EDLC with improved energy storage capacity and lifetime were developed using activated carbon and ionic liquids.

A. Ejigu, M. Edwards and D. Walsh, 2015. [Synergistic Catalyst-Support Interactions in a Graphene-Mn3O4 Electrocatalyst for Vanadium Redox Flow Batteries](http://dx.doi.org/10.1021/acscatal.5b01973) ACS Catalysis, 5(12), 7122-7130.

Redox flow batteries (RFBs) are attractive candidates for batteries due to their large energy storage capacity, flexibility of design, and their long lifetimes. A new RFB based on vanadium oxide and nitrogen-doped graphene oxide was developed and studied to optimise and understand this electrochemical system.

A. Ejigu, P. Greatorex-Davies and D. Walsh, 2015. [Room temperature ionic liquid electrolytes for redox flow batteries](http://dx.doi.org/10.1016/j.elecom.2015.01.016) Electrochemistry Communications, 54, 55-59.

Redox flow batteries (RFBs) are made of aqueous or organic electrolytes. To explore the sustainability of RFBs made of ionic liquids, chromium- and vanadium-based complexes were studied.

* Fuel cells:

S. Goodwin and D. Walsh, 2017. [Closed Bipolar Electrodes for Spatial Separation of H2 and O2 Evolution during Water Electrolysis and the Development of High-Voltage Fuel Cells.](http://dx.doi.org/10.1021/acsami.7b04226) ACS applied materials & interfaces. 9(28), 23654-23661.

Although energy production of renewable sources such as wind turbines and solar panels are advantageous, such systems depend on conditions (wind and sunlight) and are expensive. An alternative renewable energy source is the production of H2 from water. Inexpensive redox couples were used to separate H2 and O2 from water by electrolysis.