ES 1

O B S E R V A T O R Y
SCIENCE AND TECHNOLOGY (ST)
ENVIRONMENTAL SCIENCE AND TECHNOLOGY (EST)
Teacher's Guide A
Second Year of Secondary Cycle Two

BIOFUELS: SOLUTION OR PROBLEM?

STUDENT LOG

PROCEDURE: **SSC2 – SCIENCE**

EVALUATION: **SSC2 – SCIENCE**
SSC3 – SCIENCE

Observatory / Guide
11129-A

Name: _____ Group: _____ ST EST

The case study

PRESS RELEASE

Government's new biofuels plan a double win: Good for the environment and farmers

5 July 2007 – STRONGFIELD, SASKATCHEWAN Prime Minister Stephen Harper today announced a substantial investment to boost Canada's production of biofuels. Under ecoENERGY for Biofuels, the government will provide up to $1.5 billion in the form of incentives over nine years to producers of renewable alternatives to gasoline and diesel fuel.

"With leading-edge technology and abundant supplies of grains, oilseeds and other feedstocks, Canada is uniquely positioned to become a global leader in the production of biofuels," said the Prime Minister.

Last December, Canada's New Government announced a new regulation requiring a five-percent average renewable content in gasoline by 2010. At that time, the government also signalled its intention to develop a similar requirement of two-percent renewable content for diesel and heating oil by 2012.

"With the transportation sector accounting for more than a quarter of Canada's greenhouse gas output, increasing the renewable content in our fuel is going to put a real dent in emissions," said Prime Minister Harper.

Close to three billion litres of renewable fuels will be needed annually to meet the requirements of the new regulations. Canadian production in 2006 was only about 400 million litres, so the expansion will represent a tremendous economic opportunity for the country's 61 000 grain and oilseeds producers.

"Good for the environment and good for farmers, our government's investment in biofuels is a double win," said Prime Minister Harper.

Source: Office of the Prime Minister of Canada, "Government's new biofuels plan a double win: Good for the environment and farmers" [online press release], July 5, 2007 (accessed October 1, 2009).

Name: _____ Group: _____ ST EST

The case study *(continued)*

PRESS RELEASE

Food crisis: Jean Ziegler calls for a moratorium on biofuels

28 April 2008 – At a press conference in Geneva this morning, Jean Ziegler, the UN Special Rapporteur on the Right to Food, called for a five-year moratorium on biofuels and an end to speculation on food prices to control their increase, which has a brutal impact on the poor.

"In one year, the price of wheat has increased by 130 percent, the price of rice by 74 percent, the price of soybean by 87 percent, and the price of corn by 53 percent," noted Jean Ziegler in a press conference this morning before a meeting of the UN Secretary-General with the heads of various UN institutions to discuss the global food crisis.

The Special Rapporteur emphasized that the overall increase in the cost of food, evaluated at 48 percent by the Food and Agriculture Organization of the United Nations (FAO), has struck hard at the world's poorest countries.

"Nearly 2.2 billion people—one third of the world's population—live in extreme poverty or below the minimum standard of living; they cannot pay these prices over the long term," he said.

While he pointed to the massive transformation of food crops into biofuel as the main cause of this crisis, Jean Ziegler also condemned the speculation on food prices that is reportedly responsible for 30 percent of the increases.

"Of a total production of two billion tonnes of grain, 500 million are completely controlled by Cargill," he said, referring to the multinational agri-food corporation based in Minnesota, United States. . . .

The Special Rapporteur, whose role is to pursue dialogue with member nations, called for a five-year moratorium on biofuels. To control greenhouse gas emissions, he suggested electric motors and the possibility of stricter anti-pollution measures for automobile manufacturers as substitutes for promoting biofuels. . . .

Source: UN News Centre, "Crise alimentaire: Jean Ziegler propose un moratoire sur les biocarburants" [online news story], April 28, 2008 (accessed August 23, 2008). *[Translation]*

In this context, you will write a letter to the Prime Minister calling either for a moratorium on the use of biofuels or for the maintenance of programs to increase biofuel production in Canada. You must identify the environmental impact of biofuels on the lithosphere, the atmosphere and the hydrosphere and describe the ethical and economic issues surrounding their production.

Name: _____ Group: _____ ST EST

Creating the context

I ask myself questions

Name: _____ Group: _____ ST EST

Creating the context *(continued)*

I must

I think

What I know and what I must find out

What I know	What I must find out

Name: _____ Group: _____ ST EST

Creating the context *(continued)*

What I know and what I must find out *(continued)*

What I know	What I must find out

I prepare my work

Reflection

	Yes	No
Do I fully understand what I have to do?	☐	☐

Name: _____ Group: _____ ST EST

Gathering information

I do research

Name: _____ Group: _____ ST EST

Gathering information *(continued)*

I apply my research results

Name: _____ Group: _____ ST EST

Gathering information *(continued)*

I apply my research results *(continued)*

Name: _____ Group: _____ ST EST

Gathering information *(continued)*

I apply my research results *(continued)*

Name: _____ Group: _____ ST EST

Gathering information *(continued)*

I apply my research results *(continued)*

Reflection

	Yes	No
Do I fully understand the technological concepts covered in this case study?	☐	☐

Name: _____ Group: _____ ST EST

Completing the case study

I make suggestions

Reflection

	Yes	No
Have I considered other approaches?	☐	☐

Name: _____ Group: _____ ST EST

Validating the case study

I justify my approach

Name: _____ Group: _____ ST EST

My evaluation

Use the evaluation grid on page 15 to evaluate yourself. Write A, B, C, D or E in the "Me" column of the chart below.

SSC2—Makes the most of his/her knowledge of science and technology				
Criteria*	**Observable indicators**	**Me**	**Teacher**	**Comments**
1	**Creating the context** Definition of the goal and formulation of the questions for gathering information		☐ With help	
2	**Gathering information** Relevance of the advantages and disadvantages of biofuels		☐ With help	
3	**Completing the case study** Relevance of the arguments in the letter to the Prime Minister		☐ With help	
4	**Validating the case study** Justification of the arguments		☐ With help	

*** Evaluation criteria**

1 Formulation of appropriate questions
2 Appropriate use of scientific and technological concepts, laws, models and theories
3 Relevant explanations or solutions
4 Suitable justification of explanations, solutions, decisions or opinions

Name: _____ Group: _____ ST EST

My evaluation

Use the evaluation grid on page 16 to evaluate yourself. Write A, B, C, D or E in the "Me" column of the chart below.

SSC3—Communicates in the languages used in science and technology				
Criteria*	**Observable indicators**	**Me**	**Teacher**	**Comments**
1	**Gathering information** Presentation of the advantages and disadvantages of biofuels		☐ With help	
2	**Completing the case study** Composition of the letter		☐ With help	
3	**Validating the case study** Use of scientific vocabulary to justify the position on biofuels		☐ With help	

*** Evaluation criteria**

1 Accurate interpretation of scientific and technological messages
2 Appropriate production or sharing of scientific and technological messages
3 Use of appropriate scientific and technological terminology, rules and conventions

Evaluation grid

Name: _____ Group: _____

ST EST

SSC2 Makes the most of his/her knowledge of science and technology

Criteria*	Observable indicators	A	B	C	D	E
1	**Creating the context** Definition of the goal and formulation of the questions for gathering information	The questions guiding the information gathering are relevant, and the goal of the case study is very clear.	The questions guiding the information gathering are relevant, and the goal of the case study is clear.	The questions guiding the information gathering are not very relevant, OR the goal of the case study is not very clear.	The questions guiding the information gathering are not very relevant, AND the goal of the case study is not very clear.	The work must be done again.
2	**Gathering information** Relevance of the advantages and disadvantages of biofuels	All the advantages and disadvantages of biofuels are well classified and relevant.	Most of the advantages and disadvantages of biofuels are well classified and relevant.	Most of the advantages and disadvantages of biofuels are not very well classified or relevant.	Most of the advantages and disadvantages of biofuels are poorly classified and irrelevant.	The work must be done again.
3	**Completing the case study** Relevance of the arguments in the letter to the Prime Minister	The letter is very well written, and the arguments support the student's position very well.	The letter is well written, and the arguments support the student's position well.	The letter is not very well written, but the arguments support the student's position.	The letter is not very well written, and the arguments do not support the student's position.	The work must be done again.
4	**Validating the case study** Justification of the arguments	The reliability of the sources is well justified. More than one disadvantage of the student's position is relevant.	The reliability of the sources is justified. One disadvantage of the student's position is relevant.	The reliability of the sources is not well justified, OR the disadvantage of the student's position is not very relevant.	The reliability of the sources is not well justified, AND the disadvantage of the student's position is not very relevant.	The work must be done again.

*** Evaluation criteria**

1 Formulation of appropriate questions
2 Appropriate use of scientific and technological concepts, laws, models and theories
3 Relevant explanations or solutions
4 Suitable justification of explanations, solutions, decisions or opinions

Evaluation grid

Name: _____ Class: _____

SSC3 Communicates in the languages used in science and technology

Criteria*	Observable indicators	A	B	C	D	E
1	**Gathering information** Presentation of the advantages and disadvantages of biofuels	The advantages and disadvantages identified show an excellent understanding of the issues surrounding biofuels.	The advantages and disadvantages identified show a good understanding of the issues surrounding biofuels.	Some of the advantages and disadvantages identified show a certain understanding of the issues surrounding biofuels.	The advantages and disadvantages identified show little understanding of the issues surrounding biofuels.	The work must be done again.
2	**Completing the case study** Composition of the letter	The letter is very well written, and the student's position is based on many scientific arguments.	The letter is well written, and the student's position is based on several scientific arguments.	The letter is not very well written, OR the student's position is based on few scientific arguments.	The letter is not very well written, AND the student's position is based on few scientific arguments.	The work must be done again.
3	**Validating the case study** Use of scientific vocabulary to justify the position on biofuels	Scientific vocabulary is used in all the arguments.	Scientific vocabulary is used in most of the arguments.	Scientific vocabulary is barely used in the arguments.	Scientific vocabulary is not used in the arguments.	The work must be done again.

*** Evaluation criteria**

1 Accurate interpretation of scientific and technological messages
2 Appropriate production or sharing of scientific and technological messages
3 Use of appropriate scientific and technological terminology, rules and conventions

ES1

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Information documents

Ethanol

Ethanol is a liquid alcohol made of oxygen, hydrogen and carbon and is obtained from the fermentation of sugar or converted starch contained in grains and other agricultural or agri-forest feedstocks. In Canada, ethanol is presently made principally from corn and wheat. Ethanol can be produced for different applications, for example, industrial ethanol or fuel grade ethanol. Research into technology to produce ethanol from non-food sources is advancing rapidly and is close to commercialization. . . .

Ethanol is blended with gasoline to produce a fuel that has environmental advantages when compared with gasoline and can be used in gasoline-powered vehicles manufactured since the 1980s. Most gasoline-powered vehicles can run on a blend consisting of gasoline and up to 10 percent ethanol, known as "E-10," which is available at some regular service stations across Canada.

Some vehicles are specially manufactured to operate on an ethanol blend that contains up to 85 percent ethanol and at least 15 percent gasoline [E-85]. . . .

Environmental benefits

Ethanol is a renewable fuel because it is produced from biomass. Ethanol also burns more cleanly and completely than gasoline or diesel fuel.

Ethanol reduces greenhouse gas (GHG) emissions because the grain or other biomass used to make the ethanol absorbs carbon dioxide as it grows. Although the conversion of the biomass to ethanol and the burning of the ethanol produce emissions, the net effect can be a large reduction in GHG emissions compared with fossil fuels such as gasoline. The reduction depends on the feedstock and the production processes used to make ethanol.

E-10 from corn produces about three to four percent fewer greenhouse gas emissions than gasoline. E-10 made from wood or agricultural cellulosic materials would produce six to eight percent fewer emissions compared with gasoline.

Information documents *(continued)*

Societal and economic benefits

Ethanol contributes to regional economic growth and job creation, particularly in rural communities. There is great potential to capitalize on ethanol fuel because Canada has the forest resources and cropland needed to support the production of ethanol feedstocks. The development of a substantial ethanol industry would potentially mean new markets for Canadian biomass, agriculture and forestry. It would create construction and operations jobs at ethanol production plants and help strengthen and diversify rural economies.

Canadian farmers are becoming increasingly aware of this new market opportunity. Some have formed cooperatives to grow crops intended specifically as a feedstock for ethanol production. A 100-million-litres-per-year wheat-based ethanol production plant requires around 300 000 tonnes of feed grain per year and an estimated 250 000 acres to produce the feedstock. A plant this size would consume about 700 acres' worth of production per day.

Ethanol production also offers opportunities to expand cattle feedlot operations. Large volumes of distiller's grain,[1] a high-protein feed ingredient, are generated as a co-product of ethanol production.

As processes are further developed to manufacture ethanol from forest feedstock, such as wood waste, ethanol production will also create new sources of revenue for Canada's forest industry.

Source: Natural Resources Canada, Office of Energy Efficiency (OEE), "Ethanol" [Web pages], April 2007 (accessed October 1, 2009).

1. Corn residue left over from ethanol production, which can be used for cattle feed.

Information documents *(continued)*

Biofuel support policies: An economic assessment by the Organisation for Economic Co-operation and Development

EXECUTIVE SUMMARY

1. The production and use of biofuels . . . have grown rapidly over the past few years and are expected to further double in the decade to come. . . . A large number of other countries' governments have begun, or are considering, promoting biofuel production and use.

2. . . . This report estimates support to the US, EU and Canadian biofuel supply and use in 2006 at about USD 11 billion per year, projected to rise to USD 25 billion in the medium term. . . .

3. The high level of public support has placed biofuels policy at the centre of a debate about the expected environmental, energy and economic benefits. This report presents new economic analysis, provides policy recommendations and identifies areas where more research is necessary. . . .

4. There are many reasons for public interest in and support for biofuels. . . . With increased concerns about climate change, however, the reduction of greenhouse gas (GHG) emissions and fossil energy savings can safely be counted among the prime reasons to support biofuel production and use.

5. . . . Current support policies in the US, the EU and Canada target feedstocks that tend to reduce GHG emissions by much less. Biofuels produced from wheat, sugar beet or vegetable oils rarely provide GHG emission savings of more than 30 to 60 percent, while corn (maize)-based ethanol generally allows for savings of less than 30 percent. . . .

6. . . . Despite the rapid and substantial increase in crude oil prices . . ., the cost disadvantage of biofuels has widened in the past two years as agricultural commodity prices soared and thereby feedstock costs increased.

7. The medium-term impacts of current biofuel policies on agricultural commodity prices are important, but their role should not be overestimated. The price effects attributable to biofuel policies derive largely from increased demand for cereals and vegetable oils. . . .

Information documents *(continued)*

8. Current biofuel support measures are estimated to increase average wheat, maize and vegetable oil prices by about 5, 7 and 19 percent, respectively, in the medium term. . . . The new US and proposed EU initiatives could further increase commodity prices by a similar magnitude.

9. The price impact of second-generation biofuel production would depend on the amount of feedstock biomass that would be produced on current cropland. If the total production area is significantly expanded, the price effects would be reduced, but concerns over negative environmental impacts on sensitive areas and high-carbon soils, including GHG emissions, water use and biodiversity losses, would increase.

10. Linked to the price effects noted above, existing and any additional support for biofuels might have important implications for global land use and are likely to accelerate the expansion of land under crops particularly in Latin America and large parts of Africa. While this might provide additional income opportunities to generally poor rural populations, care would need to be taken to avoid possible environmental damages, including accelerated deforestation, additional release of greenhouse gases, loss of biodiversity and runoff of nutrients and pesticides.

Source: Organisation for Economic Co-operation and Development, Excerpts from the report *Biofuel Support Policies: An Economic Assessment* [online], July 16, 2008 (accessed October 1, 2009).