

Response to “Prairie Atoms: The Opportunities and Challenges of Nuclear Power in Alberta and Saskatchewan“ by Duane Bratt from September 2008

The paper “Prairie Atoms: The Opportunities and Challenges of Nuclear Power in Alberta and Saskatchewan“¹ by Duane Bratt, Department of Policy Studies, Mount Royal College, from September 2008 is part of and has been commissioned by the Canada West Foundation’s Going for Gold Project.

The Going for Gold Project has been funded by the British Columbia, Alberta, Saskatchewan, and Manitoba governments.²

The paper not merely advocates building nuclear reactors, as well as uranium mining and processing, but adds to that reprocessing and enrichment!³

Summary and Conclusion

The author Duane Bratt lists in his paper from September 2008⁴ the opportunities and challenges he perceives for nuclear power in Alberta and Saskatchewan.

This response serves as a critical review of Duane Bratt’s paper and tries to pick up the most significant points of the paper.

It should be mentioned that although the paper tries to impart a scientific approach it actually does not meet these standards at crucial places. For instance the paper uses sources in a very selective and vague way.

This response criticizes Duane Bratt’s paper in the following points:

Concerning the electricity demand the tar sands operators are not so much interested in nuclear energy and tend themselves to be net electricity exporters. Above all nuclear energy is not appropriate in the tar sands development. Generally there is no demand for electricity from nuclear power in Alberta and there will be no electricity shortage in the province without nuclear power.

Concerning greenhouse gas emissions from nuclear power the paper is very contradictory in that it states that nuclear power does not emit greenhouse gases but immediately acknowledges that there are small emissions from the entire cycle, then states that GHG emissions are comparable to renewables when indeed its own figure shows that greenhouse gas intensity of nuclear is not a

¹ **GOING FOR GOLD**

Prairie Atoms: The Opportunities and Challenges of Nuclear Power in Alberta and Saskatchewan

Duane Bratt, PhD

September 2008

The Western Canadian Economy in the International Arena

Canada West FOUNDATION

http://www.cwf.ca/V2/files/Prairie_Atoms.pdf (last accessed September 15, 2008)

² ibid

³ ibid

⁴ ibid

small number and by far not comparable to hydro and wind. On a large scale nuclear power is not able to mitigate climate change. Real solutions like energy conservation, energy efficiency, and alternatives are not considered in the paper. With these solutions the conservation of Canadian natural gas supplies could greatly be supported.

The paper gives the impression that nuclear energy is a solution to tar sands development where it actually is not.

The paper greatly plays down the Three Mile Island accident as it states the success of the reactor's safety features where indeed the accident resulted from a chain of many technical and human errors leading eventually to the meltdown of a large part of the reactor core. Through this meltdown significant amounts of radioactivity were released. There was great luck involved in that the containment structure was not disrupted by the hydrogen explosions that occurred within.

Concerning the Chernobyl disaster the paper vastly belittles the catastrophe. It portrays a study that was prepared in cooperation with and under the authority of nuclear proponents (IAEA) as "the most authoritative study"⁵. Apart from the fatalities which are underestimated in orders of magnitude this study does not consider the catastrophic impacts on health, social life, and economic structures resulting from the Chernobyl disaster.

The paper does not reflect on the actual environmental footprint of nuclear power which would have to consider the whole nuclear chain with its consumption of resources and its generation of waste streams, e.g. land use for waste rocks and mill tailings in the uranium mining and milling process, the use and the contamination of surface water and groundwater, the atmospheric contamination. The environmental footprint of nuclear power would have to consider uranium mining and milling, fuel processing and production, construction, operation, maintenance, refurbishment, and decommissioning of all kinds of facilities, e.g. nuclear reactors, transportation, and waste fuel management.

Even in the restricted scope the paper applies the term "environmental footprint" the effective land use of wind farms and solar plants was vastly exaggerated.

The paper indirectly asks for government funding and subsidizing of nuclear projects without elaborating on the spending of the same money for safer technologies supporting energy conservation, energy efficiency, and alternatives.

In its policy recommendations the paper advertises the expansion/development of nuclear power in Alberta and Saskatchewan.⁶ This and additional recommendations in favour of nuclear power are based if at all on very weak foundations. Alternative energy solutions are not considered appropriately.

One of the policy recommendations that should be a matter of great concern reads: "More research and development money needs to be dedicated by governments and the nuclear industry for recycling nuclear waste into reactor fuel."⁷

⁵ ibid

⁶ ibid

⁷ ibid

This recommendation is presented without any elaboration of the related issues and problems of the most dangerous waste fuel reprocessing. It is the attempt of clandestinely introducing the reprocessing technology of spent fuel into Canada.

Electricity Demand

Concerning opportunities the paper states as prairie opportunity 2 the meeting of the electricity demand⁸ and quotes the Alberta Electric System Operator as Alberta needing another 6,650 megawatts of electricity by 2024.⁹ (Bruce Power said there are projections for a 5,000-megawatt shortfall around 2019.)

One of the reasons for the electricity demand given in the paper is the alleged increased use of electricity in the production of other energy fields (most notable oil and gas).¹⁰ In fact companies dealing with the extraction and upgrading in the tar sands tend to be net electricity exporters as will be shown below!¹¹¹²¹³¹⁴

Actually there is no demand for electricity from nuclear power in Alberta and there will be no electricity shortage in the province without nuclear power:

1. The tar sands primarily need energy in form of steam, not electricity. Nuclear power plants are not appropriate to replace the enormous quantities of natural gas used.

⁸ ibid

⁹ ibid

¹⁰ ibid

¹¹ **EDMONTON JOURNAL**

Nuclear power buyer not for real

Firm behind Peace River reactor plan calls claim a misunderstanding

Gordon Jaremko, The Edmonton Journal

Published: Monday, September 10

<http://www.canada.com/edmontonjournal/news/story.html?id=cc986eb9-11a2-427c-b308-5f45409edf62&k=51525>

(last accessed: September 16, 2007)

¹² **Cogeneration & On-Site Power Production**

Current Issue-Cogeneration & On-Site Power Production

Cogeneration and the Alberta oil sands - cogeneration benefits are maximized with extraction and upgrading integration

Jeremy Moorhouse

Bruce Peachey

http://www.cospp.com/display_article/303182/122/CRTIS/none/none/Cogeneration-and-the-Alberta-oil-sands---cogeneration-benefits-are-maximized-with-extraction-and-upgrading-integration-/ (last accessed: September 16,

2007)

¹³ National Energy Board

CANADA's Oil Sands:

Opportunities and Challenges to 2015

An ENERGY MARKET ASSESSMENT

May 2004

<http://dsp-psd.pwgsc.gc.ca/Collection/NE23-116-2004E.pdf> (last accessed: September 16, 2007)

¹⁴ **Critics pan Alberta nuke plan**

The Globe and Mail: Shawn McCarthy - March 19, 2008

OTTAWA

<http://www.energyquest4nanticoke.ca/pan.htm> (last accessed April 30, 2008)

Main players in the tar sands development do not want nuclear power.¹⁵

Furthermore, as data from the Canadian Energy Research Institute (CERI), a semi-official agency supported by government and business foundations that has access to industry information, shows the northern Alberta bitumen belt as a net electricity supplier, not a buyer. Alberta's tar sands operators tend to use the steam from their thermal production processes in cogeneration plants to produce power for their oilsands complexes and sell surpluses into the Alberta electricity grid.¹⁶ (See also^{17,18}.)

TransCanada and CERI estimate tar sands cogeneration could produce more than 3,000 megawatts of surplus electricity for export.¹⁹ (See also²⁰.)

The National Energy Board stated in its report of May 2004 titled CANADA's Oil Sands: Opportunities and Challenges to 2015, An ENERGY MARKET ASSESSMENT: "It is estimated that oil sands based cogeneration ('s) ... surplus capacity could grow to 1 760 MW or more by 2015."²¹

The tendency with upgrader facilities, as holds true for the tar sands production facilities in general, as seen above, is to produce their own electricity and even export electricity to the grid.

For instance, the project description for the Petro-Canada Sturgeon Upgrader Project Fort Hills states: "The co-generation unit installed in Phase 2/3 will provide power for the Project, and a net power production of 157 MW will be potentially exported to the grid."²²

¹⁵ Nuclear power buyer not for real

ibid

¹⁶ ibid

¹⁷ Cogeneration and the Alberta oil sands

ibid

¹⁸ CANADA's Oil Sands:

Opportunities and Challenges to 2015

ibid

¹⁹ Nuclear power buyer not for real

ibid

²⁰ Cogeneration and the Alberta oil sands

ibid

²¹ CANADA's Oil Sands:

Opportunities and Challenges to 2015

ibid

²² Sturgeon Upgrader Project

PETRO-CANADA

Reports & Regulatory Filings

Fort Hills

Sturgeon Upgrader Application Documentation

Volume 1 - Project Description

4 - Utilities and Offsite Systems

http://www.petro-canada.ca/pdfs/4_Utilities_and_Offsite_Systems.pdf (last accessed September 5, 2007)

2. A very conservative estimation concerning future electricity demand is given in a paper titled “Will Expected Growth in Alberta’s Electricity Demand be met by Private Generation Firms?”²³ The paper predicts a shortfall of 2,711 MW for the Alberta Interconnected Electricity System (AIES) load in 2024 compared with a surplus of 269 MW projected by the Alberta Electricity System Operator (AESO).^{24,25}

Both projections started out from an effective capacity of 9,636 MW for the year 2005 and took a 10% contingency for the total AIES demand into consideration. In the calculations for 2024 a projected peak winter electricity demand of 11,681 MW in terms of AIES load was used compared with a AIES load of 8,286 MW for 2007.²⁶

Similar to the predictions made by AESO, a study of the Canadian Energy Research Institute came to the conclusion that northern Alberta will soon produce more electricity than it uses.²⁷

Furthermore the National Energy Board’s report²⁸ points out: “... the perception that the Alberta market is not large enough to absorb all the potential oil sands cogeneration capacity. ... a supply shortage is not expected in the mid to long-term despite the retirement of older generation.”

“Robert Page, a University of Calgary environmental economist and former vice-president of Alberta utility company TransAlta Corp., said there are enough plans for new generation now in the works - excluding nuclear – to create a surplus of power in Alberta. ‘Everyone is going to be real cautious on [nuclear] because there is a real potential for surplus power in Alberta,’ Mr. Page said.

There are plans for new power plants fired by coal and natural gas, as well as a rapidly growing wind power supply, he said. With a potential surplus looming, few buyers will want to lock into the kind of long-term contracts that Bruce Power will need to back up its financing, Mr. Page said.”²⁹

With regards to the need for upgrading the Alberta Electricity grid, the paper also fails to mention that the need for an upgrade would be minimized by using a “distributed generation” model

²³ **Will Expected Growth in Alberta’s Electricity Demand be met by Private Generation Firms?**

BUEC 560 Term Paper

March 18, 2007

Derek Hollmann

http://www.business.ualberta.ca/cabree/pdf/2007%20Winter/Hollman_560.pdf (last accessed: September 17, 2007)

²⁴ *ibid*

²⁵ **20-YEAR OUTLOOK DOCUMENT (2005 – 2024)**

ALBERTA ELECTRIC SYSTEM OPERATOR

June 2005

http://www.aeso.ca/files/AESO_20-YearOutlookDocument_2005_Final.pdf (last accessed: September 17, 2007)

²⁶ **Will Expected Growth in Alberta’s Electricity Demand be met by Private Generation Firms?**

ibid

²⁷ **Nuclear power buyer not for real**

ibid

²⁸ **CANADA’s Oil Sands:**

Opportunities and Challenges to 2015

ibid

²⁹ **Critics pan Alberta nuke plan**

ibid

rather than large plants which are centralized. Using sustainable energy sources such as wind, geothermal, biogas, micro-hydro, co-generation and solar power sources could also add a degree of stability on the grid whereby the failure of a large electricity producer would require an equal or larger backup source. Such a failure could come from weather related events, mechanical failure, human error or human induced actions.

Greenhouse Gas Emissions from Nuclear Power

In prairie opportunity 3, mitigating climate change, the paper refers predominantly to the oil sands production in Alberta as a huge source of GHGs today but even more so in future projections.³⁰ The paper recommends nuclear power to mitigate the problem: “Since nuclear power does not emit greenhouse gases (although there are small emissions from the entire cycle) ...³¹ and further states: “... nuclear power’s GHG emissions are comparable to renewables.”³² In figure 1 the greenhouse gas intensity of nuclear is quoted as being 62.5 grams of CO₂-equivalent/kWh³³ which is indeed not a small number and by far **not comparable** to hydro and wind! (See figure 1 in the paper.³⁴)

Furthermore nuclear power is unable to serve as a significant energy source in the tar sands development.³⁵

Finally the argument of mitigating the climate problems that result from the tar sands development through the deployment of nuclear power is phony as it would help produce the fossil fuels that would emit more greenhouse gases.

Concerning future cost advantages as result of price additions for carbon emissions at least hydro and wind will be by far better off than nuclear power. (See figure 1 in the paper.) Solutions not mentioned in the paper such as energy conservation or energy efficiency are even far more rewarding.

Replacing Natural Gas with Nuclear Power

In prairie opportunity 4 the paper gives the impression that nuclear power was the only possibility in replacing gas-fired plants in electricity production³⁶ not mentioning the immense potential of saving electricity, energy efficiency and alternatives.

³⁰ **Prairie Atoms: The Opportunities and Challenges of Nuclear Power in Alberta and Saskatchewan**

ibid

³¹ ibid

³² ibid

³³ ibid

³⁴ ibid

³⁵ **Nuclear Energy is No Solution to Tar Sands Development**

Heinz-Juergen Peter

http://nuclearfreealberta.ca/Report_I_Nuclear%20Energy%20is%20No%20Solution%20to%20Tar%20Sands%20Development_Version_4.doc

at:

KEEP ALBERTA NUCLEAR FREE

Resources

No Nuclear Power in the Tar Sands Development

<http://www.nuclearfreealberta.ca/resources.html> (last accessed September 15, 2008)

Nuclear Energy is No Solution to Tar Sands Development

Additionally the paper again conveys the possibility of using nuclear power in the tar sands development³⁷ where it is actually not possible (see above). Interestingly enough the paper acknowledges the technical problems with the steam production in the tar sands development³⁸ I tried to impart the problem to the nuclear proponents in their early proposals. Actually these problems are the main reason for the impossibility of replacing the natural gas in the tar sands development through nuclear power.

After stating these technical problems the paper again reverts to the use of electricity in the tar sands development³⁹ which I already debunked above as extraction and upgrading in the tar sands tends to be accompanied by net electricity production.

The paper tries to circumvent the main reasons for the early depletion of natural gas supplies in Alberta which will significantly restrict Albertans' source of heating. The two main reasons are first the exports of natural gas to the US and second the consumption in the tar sands development which again almost exclusively results in the export of the products to the US.

Reprocessing of Spent Fuel in Canada?

The paper seems to be vague with the term "reprocessing" which generally means the reprocessing of spent fuel. Does the paper try to obscure plans of introducing this most dangerous technology into Canada (e.g. under the umbrella of the "Global Nuclear Energy Partnership" (GNEP)) by not applying the term "reprocessing" appropriately and consistently?

Nuclear Power in Saskatchewan?

In prairie opportunity 5 the paper refers to the current proposal from Bruce Power to build a twin 1,000 megawatt reactor in Saskatchewan "... either for electricity generation in Saskatchewan or for the oil sands across the border in Alberta."⁴⁰ As is the case with Alberta the demand for electricity from nuclear power plants is highly questionable for Saskatchewan. Again different solutions (energy conservation, energy efficiency, and alternatives) are far more appropriate. Nuclear power is neither a clean nor a reliable solution to generating new electricity.

The Three Mile Island Accident

In Challenge 1: Nuclear Safety, the paper states that in the case of the Three Mile Island accident the success of the reactor's safety features had been revealed⁴¹ a kind of argument the nuclear proponents always like to present. One asks why the "reactor's safety features" allowed the accident to happen in the first place. Indeed the accident resulted from a chain of many technical

³⁶ **Prairie Atoms: The Opportunities and Challenges of Nuclear Power in Alberta and Saskatchewan**

ibid

³⁷ ibid

³⁸ ibid

³⁹ ibid

⁴⁰ ibid

⁴¹ ibid

and human errors leading eventually to the meltdown of a large part of the reactor core. Through this meltdown huge amounts of radioactivity were released although the containment structure prevented much of that radioactivity from escaping into the environment (still significant amounts of radioactivity escaped into the environment or were released intentionally). There was great luck involved in that the containment structure was not disrupted by the hydrogen explosions that occurred within.

The Chernobyl Disaster

Concerning the Chernobyl disaster, “the most authoritative study”⁴² quoted in the paper is highly questionable, as it greatly belittles the catastrophe. The “UN agencies”⁴³ that undertook this “most authoritative study” are bound by the International Atomic Energy Agency (IAEA) which propagates the peaceful use of nuclear power, i.e. nuclear power plants. Apart from the fatalities which are underestimated in orders of magnitude in this “most authoritative study” it does not consider the catastrophic impacts on health, social life, and economic structures resulting from the Chernobyl disaster.

The following quotes are from [chernobyl.info](http://www.chernobyl.info), the international communications platform on the longterm consequences of the Chernobyl disaster.⁴⁴

White Russia or Belarus:

“The nuclear disaster at Chernobyl effectively deprived the country of 22 per cent of its agricultural land and 21 per cent of its forests. The official Chernobyl Committee in Minsk, which is responsible for dealing with the consequences of the disaster, estimates the total damage for the Republic at USD 235 billion... Chernobyl-related costs accounted for 22.3 per cent of the country's national budget in 1991, and in 1996 it was still 10.9 per cent. Currently the republic is investing about 6 per cent of its budget in the official Chernobyl programme ...”

Ukraine:

“The state and the economy are still feeling the effects of the Chernobyl nuclear disaster... Currently, 5-7 per cent of the national budget is consumed by dealing with the consequences. By 2015, Ukrainian experts estimate that the disaster will have cost the economy a total of USD 201 billion ... In 1992 Ukraine spent about 15 per cent of its national budget on managing the effects of the disaster, and in 1996 it was still 6 per cent. Today the proportion is 5-7 per cent ...”

“Belarus and Ukraine levy an emergency tax, or Chernobyl tax, for dealing with the disaster. Initially, all companies, except for those in the agricultural sector, had to pay 18 or 19 per cent of their salary costs to the State. Later this tax was levied at the amount of 4%. Starting with 2007 it was abolished.”

⁴² ibid

⁴³ ibid

⁴⁴ **[chernobyl.info](http://www.chernobyl.info)**

The international communications platform on the longterm consequences of the Chernobyl disaster
<http://www.chernobyl.info/index.php?userhash=38236668&navID=1&IID=2> (last accessed September 16, 2008)

“... of the 800,000 ‘liquidators’ (soldiers deployed to clean up the reactor compound) ..., 25,000 ... have since died (according to official reports from the three former Soviet states affected).“

“(According ‘TORCH’ (The Other Report on Chernobyl)) ... about 30,000 to 60,000 excess cancer deaths are predicted, 7 to 15 times greater than IAEA/WHO’s published estimate of 4,000.“

“(The Chernobyl disaster resulted in) ... the evacuation and resettlement of 350,400 people ...“

Nuclear Accidents

Compared with accidents in other fields nuclear disasters can happen in magnitude anytime and at any nuclear plant that render large areas uninhabitable for generations and leave their legacy for a very long time. Figure 2 in the paper quotes only the direct fatalities of nuclear reactor accidents.⁴⁵ What does “direct” mean in this respect? Nuclear reactor accidents in fact have a far greater range of non direct fatalities than other energy sources (see above).

The new Generation III+ reactors mainly aim at reducing the costs which would most probably conflict with safety considerations. I would argue that “... even more enhanced safety features“⁴⁶ would merely be introduced if they don’t collide with cost considerations.

Environmental Footprint of Nuclear Power

In challenge 2 the paper uses the term “environmental footprint“ in a restrictive meaning which only considers the area of land on which facilities are built. Generally the “environmental footprint” is a much more complex concept. It describes the effective consumption on the world considering the consumption of resources and the generation of waste including for instance greenhouse gas emissions etc. In general the whole chain from the beginning to the end has to be considered.

In the case of nuclear power this would mean for instance the land use in the uranium mining and milling process including the land use for waste rocks and mill tailings.

Generally the environmental footprint would have to consider the generation of solid and liquid (hazardous) wastes, the use and the contamination of surface water and groundwater, the atmospheric contamination through (hazardous) pollutants and greenhouse gases, the impacts on biota such as the contamination and elimination of the biota.

For all these fields of environmental consumption the whole nuclear chain would have to be examined: uranium mining and milling, fuel processing and production, construction, operation, maintenance, refurbishment, and decommissioning of all kinds of facilities, e.g. nuclear reactors, transportation, waste fuel management.

⁴⁵ **Prairie Atoms: The Opportunities and Challenges of Nuclear Power in Alberta and Saskatchewan**

ibid

⁴⁶ ibid

The environmental footprint would include radioactive and non-radioactive wastes and releases, routine and accidental releases, and the areas contaminated through (catastrophic) accidents (this would include the Chernobyl disaster! See above.).

All this was not reflected by the paper. But even when the paper applies the term “environmental footprint” in the restricted scope of only the land use the figures given vastly exaggerate the actual (effective) land use of wind farms and solar plants.

Land Use of Wind Farms and Solar Plants as Claimed in the Paper

The paper speaks of about 770 square kilometres that would be occupied by wind farms for the production of 1,000 MWe of electricity and solar plants that would “require about 150 square kilometres plus land for storage and retrieval” for the same electricity produced.⁴⁷

Effective Land Use of Wind Farms

Concerning the wind farms I suppose that the paper refers to the total area these wind farms would be dispersed over. Apparently most of the land where wind farms operate on can still be used for other purposes than mere wind production. “...less than 5% of this land would be physically occupied by wind turbines, electrical equipment, and access roads.”⁴⁸

The following quote serves as an example for the actual land use of wind farms: “... a wind farm consisting of 17 turbines (each 660 kW) ... 7.4 acres are used for the turbine foundations, transformers and access roads.”⁴⁹

With these numbers my calculation yields: Overall power = 17 * 660 kW = 11,220 kW, approximately 11 MW; 7.4 acres = 0.02994 square kilometres; 1,000 MW would be approximately 0.02994 / 11 * 1,000 square kilometres, which is approximately 2.7 square kilometres. The area given in the paper of about 770 square kilometres is almost 300 times greater!

Effective Land Use of Solar Plants

Concerning solar plants the following quote refers to a solar plant recently opened in Germany: “Shell Solar, GEOSOL and WestFonds, have officially opened the worlds largest grid connected PV power plant ... with an output of 5 MW... The PV power plant is situated on a former lignite-mine ash deposit in Espenhain near Leipzig, once one of the most polluted areas of Germany. The power plant is built on 21.6 ha of land of which 16 ha are used for the solar system ...”⁵⁰

⁴⁷ ibid

⁴⁸ **Wind Energy FAQ**

How Much Land is Required for Large Wind Plants?

<http://www.awea.org/faq/land.html> (last accessed September 15, 2008)

⁴⁹ **Madison Gas and Electric**

our environment

Wind Farm Facts

http://www.mge.com/environment/wind/windfarm_facts.htm (last accessed September 15, 2008)

⁵⁰ **ECOMALL**

SHELL SOLAR OPENS WORLD’S LARGEST SOLAR PARK

Converting these numbers to 1,000 MW the resulting land use would be with 21.6 ha or 0.216 square kilometres: $0.216 / 5 * 1,000$ square kilometres = 43.2 square kilometres which is much less than the number given in the paper (150 square kilometres). Actually the “environmental footprint“ is much smaller than the factual land use as solar plants can be built on land that is already used or on roofs of existing buildings.

Government Funding and Subsidizing of Nuclear Projects?

In challenge 9: government funding the paper indirectly asks for funding or subsidizing nuclear projects.⁵¹ The paper asks: “... would government money that led to a reduction in GHG emissions by replacing coal with nuclear be wrong?”⁵² Once again the real issue is that this money would be far better spent in safer technologies supporting energy conservation, energy efficiency, and alternatives.

More Research and Development Money from Governments and the Nuclear Industry for Recycling Nuclear Waste into Reactor Fuel?

In their policy recommendations the paper suggests in one of their points: “More research and development money needs to be dedicated by governments and the nuclear industry for recycling nuclear waste into reactor fuel.”⁵³ Interestingly enough this recommendation is given without any further treatment of the related issues and problems of the most dangerous waste fuel reprocessing (see above in this response).

This article was written by Heinz-J. Peter, an independent nuclear physicist living in St. Albert, Alberta.

<http://ecomall.com/greenshopping/shellsolar.htm> (last accessed September 15, 2008)

⁵¹ **Prairie Atoms: The Opportunities and Challenges of Nuclear Power in Alberta and Saskatchewan**

ibid

⁵² ibid

⁵³ ibid