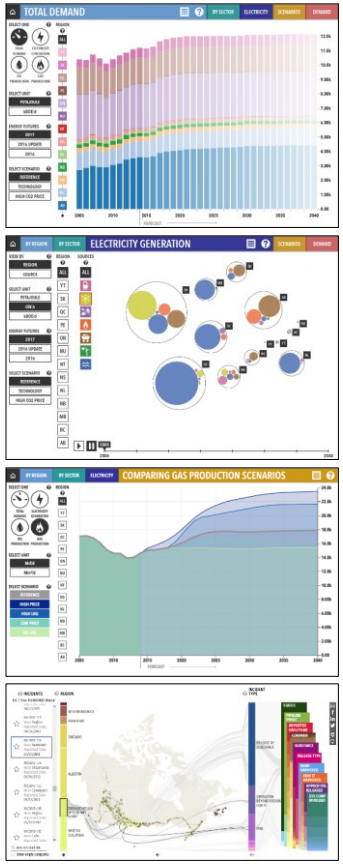

Figure 1. Visualizations of Canada's National Energy Board Data: *Energy Futures* (top three images) and *Pipeline Incidents* (bottom image).

Democratizing Open Energy Data for Public Discourse using Visualization

Søren Knudsen[1], Jo Vermeulen[1,2], Doris Kosminsky[3], Jagoda Walny[1], Mieka West[1], Christian Frisson[1], Bon Adriel Aseniero[1], Lindsay MacDonald Vermeulen[1,4], Charles Perin[1,5], Lien Quach[1], Peter Buk[1], Katrina Tabuli[1], Shreya Chopra[1], Wesley Willett[1], Sheelagh Carpendale[1]

[1]University of Calgary, Canada

[2]Department of Computer Science, Aarhus University, Denmark

[3]Federal University of Rio de Janeiro, Rio de Janeiro, Brazil

[4]Alexandra Institute, Denmark

[5]Department of Computer Science, City, University of London, UK

{sknudsen, jkwalny, mieka.west, christian.frisson, baasenie, lnquach, pkpbuk, katrinapauline.tabul, shreya.chopra, wesley.willett, sheelagh}@ucalgary.ca; jo.vermeulen@cs.au.dk; doriskos@ufrj.br; lindsay.vermeulen@alexandra.dk; charles.perin@city.ac.uk

CHI'18 Extended Abstracts, April 21–26, 2018, Montréal, QC, Canada

ACM ISBN 978-1-4503-5621-3/18/04.
https://doi.org/10.1145/3170427.3186539

Abstract

For this demo, we will show two interactive visualizations: *Energy Futures* and *Pipeline Incidents*. We designed and developed these visualizations as part of an open data initiative that aims to create interactive data visualizations to help make Canada's energy data publicly accessible, transparent, and understandable. This work was conducted in collaboration with the National Energy Board of Canada (NEB) and a visualization software development company, VizworX.

Author Keywords

Open data, data visualization, citizen engagement, information visualization, data democratization.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction

Both individuals [1] and researchers [2] are increasingly conscious of the potential environmental and social impacts of energy production. Moreover, as citizens in our modern society, we are increasingly aware that vast amounts of data exist about our world. Effective use of this data has the potential to lead to a more informed society and an increasingly data-driven public discourse around topics like energy use. However, the data that is currently made available to the public is

About the NEB

The National Energy Board is a regulatory agency created in 1959 by the Government of Canada to oversee the oil, gas and electric utility industries. The NEB regulates approximately 72,000 km of the oil and natural gas pipelines in Canada (roughly 10%), and is involved in overseeing their construction, operation and abandonment. This includes holding public hearings and inspecting pipelines. Other NEB responsibilities include powerlines, energy development, and trade.

usually released online as collections of numbers in tables, as raw text, data files, or databases. Unfortunately for citizens, these representations are often not comprehensible or useful without specialized domain knowledge or data wrangling skills. Our goal is to facilitate a more practical data transparency for the general public. This demo highlights our work in partnership with Canada's National Energy Board (NEB), which explores how data visualizations can support data democratization and facilitate conversations between governments and their constituents.

As the main Canadian energy regulator (see sidebar), the NEB is responsible for collecting data on a wide range of energy-related topics. A part of our ongoing research, we created visualizations for two high-priority datasets: Energy Futures and Pipeline Incidents.

To better understand these datasets and the NEB processes that produced them, we engaged in a data-understanding process involving data analysis, workshops, and stakeholder engagement. This process (conducted with collaborators at the NEB and VizworX) informed the design of interactive visualizations specifically intended to make the data more accessible and meaningful for everyday people.

Through this demo, we introduce visitors to this important and timely data and discuss the process of creating visualizations through a multi-party collaboration. We also show several visualization innovations that emerged from this project including rose charts (Fig. 2), a unique combination of parallel sets and parallel coordinates (Fig. 3), and design elements that enable online conversations around visualizations.

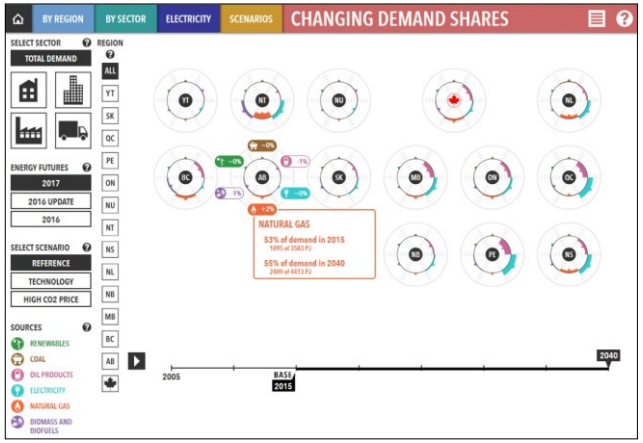

Figure 2. Example of *Energy Futures* visualization: Changing demand for the different types of energy for each province.

Energy Futures Visualization

Many Canadians are concerned about how energy is produced and transported, as well as our increasing use of it. In particular, there are rising concerns about these activities' impact on the environment. Our Energy Futures visualization highlight the NEB's projections of energy supply and demand in Canada over the next 25 years. The visualization provides an explorable and accessible representation of three *Energy Futures* reports released by the NEB [6] from 2016-2017.

The visualization shows four kinds of projections from the Energy Futures reports covering a period from 2005 to 2040 (see sidebar on next page). We provide five unique and tailored ways to explore the Energy Futures visualization: Demand and production by region (Fig.

Energy Futures Data

The energy futures data has projections for **total energy demand** of electricity, natural gas, petroleum products, coal, and renewable fuels. This does not include demand for energy used to generate electricity. There are also projections for **electricity generation** by ***source*** (oil products, nuclear, biomass and biofuels, natural gas, coal, solar/wind/geothermal, and hydro), crude **oil production**, and **natural gas production**. The data is divided into ***regions*** — 13 Canadian provinces and territories — and ***sectors*** (residential, commercial, industrial, and transportation). Each Energy Futures report provides several projections based on select ***scenarios***. For example, the 2017 report includes three scenarios: a baseline, a high carbon price scenario, and a technology scenario in which Canada has greater adoption of emerging production and consumption energy technologies.

1.1); Energy demand by sector; Electricity generation by region and source (Fig. 1.2); Comparison of scenarios (Fig, 1.3); and relative change in demand shares by region (Fig. 2). These visualizations employ a mix of familiar and novel visual representations.

Through lab studies [3] and web analytics, we observed that visitors are particularly drawn to the Electricity generation visualization (Fig. 1, second from top), which uses an animated bubble chart. We also introduce a novel visualization called a *rose chart* (Fig. 2) to show projected changes in energy demand share. Each rose represents a single province or territory. It is sliced into separate coloured pieces per energy source. and a single slice represents relative changes between two years selected on a timeline. A key insight from this visualization is that while Canadians' use of green energy is expected to increase in the future, its relative share of the total demand is somewhat stable. This highlights the challenges ahead for reducing Canadian dependence on fossil fuels.

Pipeline Incidents Visualization

Every day, the Canadian network of underground pipelines transports millions of litres of oil and gas. At certain times unintended events (or *incidents*) occur. While some incidents are minor, others involve explosions, injury, or adverse effects on the environment.

Our Pipeline Incidents visualization (Fig. 1 (bottom) and 3) shows data about incidents from 2008 onwards (see sidebar on next page). This unique design combines two visualization techniques — parallel coordinates [4] and parallel sets [5] — to simultaneously display information about individual incidents in the context of aggregate relationships. Here, parallel sets show the

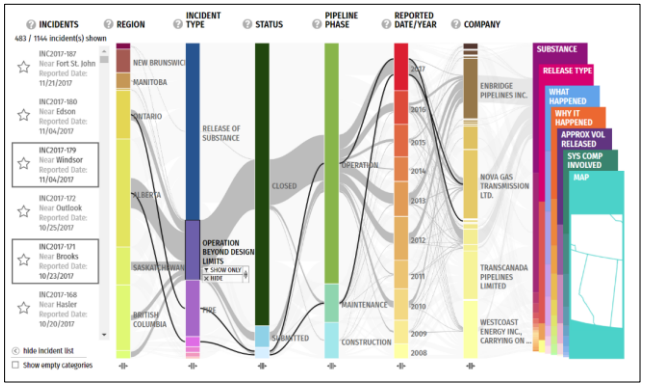

Figure 3. The Pipeline Incidents visualization, here showing 3 dimensions: incident type, what happened, and an estimated reason for the incident.

aggregate relationships between dimensions, while parallel coordinates show specific details about individual incidents through interaction. By overlaying parallel coordinates on parallel sets, the visualization provides detail in context, allowing people to follow a specific incident, while keeping an overview of general trends.

In the interest of openness and to reach a wide audience, we designed this visualization around simple views that are easy to read and learn. While the data is quite complex, the visualization uses a consistent representation pattern that a viewer only needs to learn once, and can be introduced using simple, annotated views (Fig. 3). We also designed the visualization to be easily shareable. Every state of the visualization has a unique URL, making it possible to share and refer to specific views and incidents in online conversations.

Pipeline incidents are of great interest to many members of the public, including people who live and work near pipelines as well as people with environmental and

Incidents Data

The incidents data describes approximately 1100 incidents (as of January 22nd, 2018) which occurred on or around pipelines and facilities regulated by the NEB since 2008. Our Pipeline Incidents visualization (Fig. 3) shows the causes, locations, status, company names, dates and other features associated with each incident using a unique parallel visualization containing up to 13 stacked columns. Viewers can explore the entire collection by adding, removing, or rearranging columns; reordering categories; filtering; and following the connections between related dimensions.

Visualizations

Both visualizations in this demo are available for the general public online.

Energy Futures:
ilab.cpsc. ucalgary.ca/energyvis/energy-futures

Pipeline Incidents*:*
ilab.cpsc. ucalgary.ca/energyvis/pipeline-incidents

safety concerns about the energy sector. By providing this data in an interactive format, the incidents visualization provides access to information that was previously *available* but largely *invisible* to the public. In doing so, it promotes a more inclusive discourse about pipeline incidents to a wider range of citizens.

Conclusion

These two visualizations, as well as the broader research and design effort that produced them, represent an initial foray into the rich and important space of *data democratization*. Building on these initial visualizations, our ongoing research continues to examine how visual and accessible tools can empower citizens and enable greater confidence in public institutions. While our initial results are promising, critical questions remain: *How can public institutions more efficiently create and deploy visualizations to increase the accessibility of a wider range of data? How can more social visualization tools encourage public engagement and support more robust discourse? How can public visualizations contextualize and teach viewers about data, while remaining objective and supporting multiple interpretations?*

In Canada, as in much of the world, the energy sector represents one of the most promising and important areas for public discourse. Energy continues to drive Canada's economy. Oil and gas pipelines cross public as well as privately owned land, while trains carrying energy products cross through towns and cities, where 82% of Canadians reside. As a result, the range of stakeholders who may benefit from access to this kind of data is vast, and the potential impact of democratizing tools is profound.

Our Energy Futures and Pipeline Incidents visualizations showcase how visual tools can help increase the accessibility of public data. As such, our demo will emphasize the challenges associated with designing for public data, as well as the unique designs and insights drawn from our initial engagements. Moreover, it hints at the potential benefits of open data visualization for a much wider range of public institutions and domains.

Acknowledgements

We thank Annette Hester, Katherine Murphy, and Peter Watson and their teams at the NEB for facilitating and supporting this project. We also thank the software development team at VizworX.

References

1. Oliver Bates, Mike Hazas, Adrian Friday, Janine Morley, and Adrian K. Clear. 2014. Towards an Holistic View of the Energy and Environmental Impacts of Domestic Media and IT. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, ACM, 1173–1182.
2. Oliver Bates, Vanessa Thomas, and Christian Remy. 2017. Doing Good in HCI: Can We Broaden Our Agenda? *Interactions* 24, 5: 80–82.
3. T. Blascheck, L. MacDonald Vermeulen, J. Vermeulen, et al. 2018. Exploration Strategies for Discovery of Interactivity in Visualizations. *IEEE Transactions on Visualization and Computer Graphics* PP, 99: 1–1.
4. Alfred Inselberg. 1985. The plane with parallel coordinates. *The visual computer* 1, 2: 69–91.
5. R. Kosara, F. Bendix, and H. Hauser. 2006. Parallel Sets: interactive exploration and visual analysis of categorical data. *IEEE Transactions on Visualization and Computer Graphics* 12, 4: 558–568.
6. National Energy Board of Canada. 2017. *Canada's Energy Future 2017: Energy Supply and Demand Projections to 2040*. NEB.