2025

frank.computer

Softerware

Re-imagining data visualizations as malleable interfaces

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My work has influenced:

15+ Policy orgs and governments worldwide

World Health Organization

European Commission

USWDS

110+ Tech, news, and non-profit companies/orgs

Microsoft

GitHub

Azure

HIGHCHARTS

Adobe

jupyter

The New York Times

REUTERS

BBC

20+ Undergraduate and graduate courses

Carnegie Mellon University

Massachusetts Institute of Technology

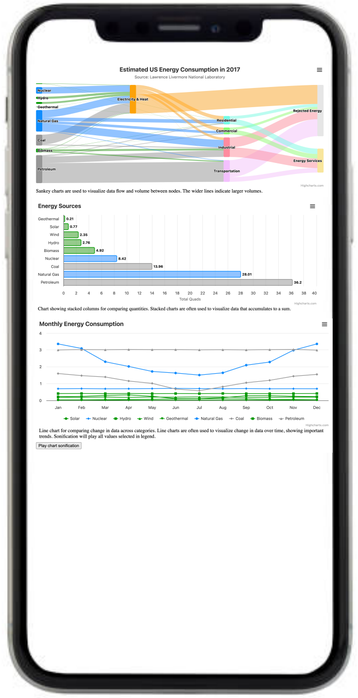
UNIVERSITY of WASHINGTON

Northwestern University

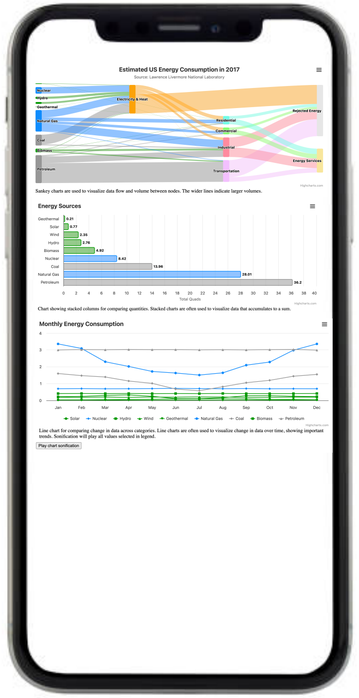
COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK

Check out this cool dashboard I made!

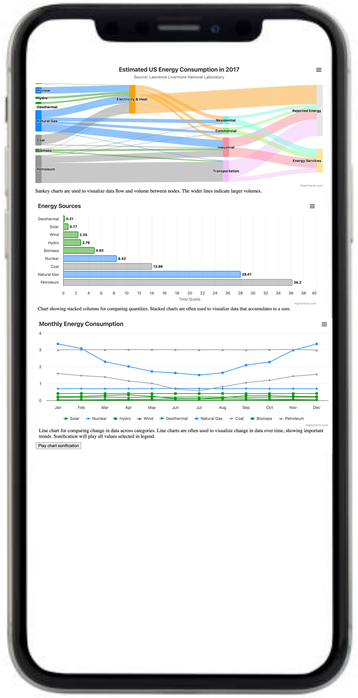
Oh, is it a layout problem?

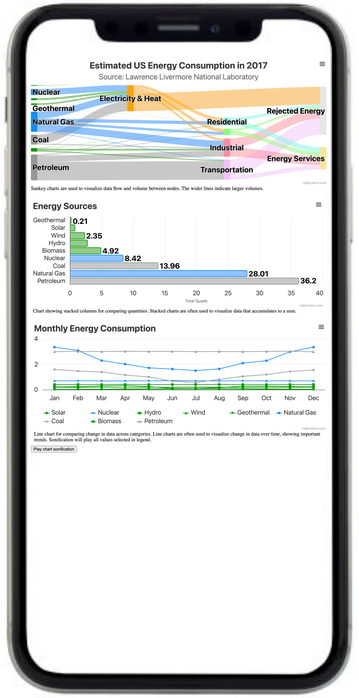


An obvious improvement!

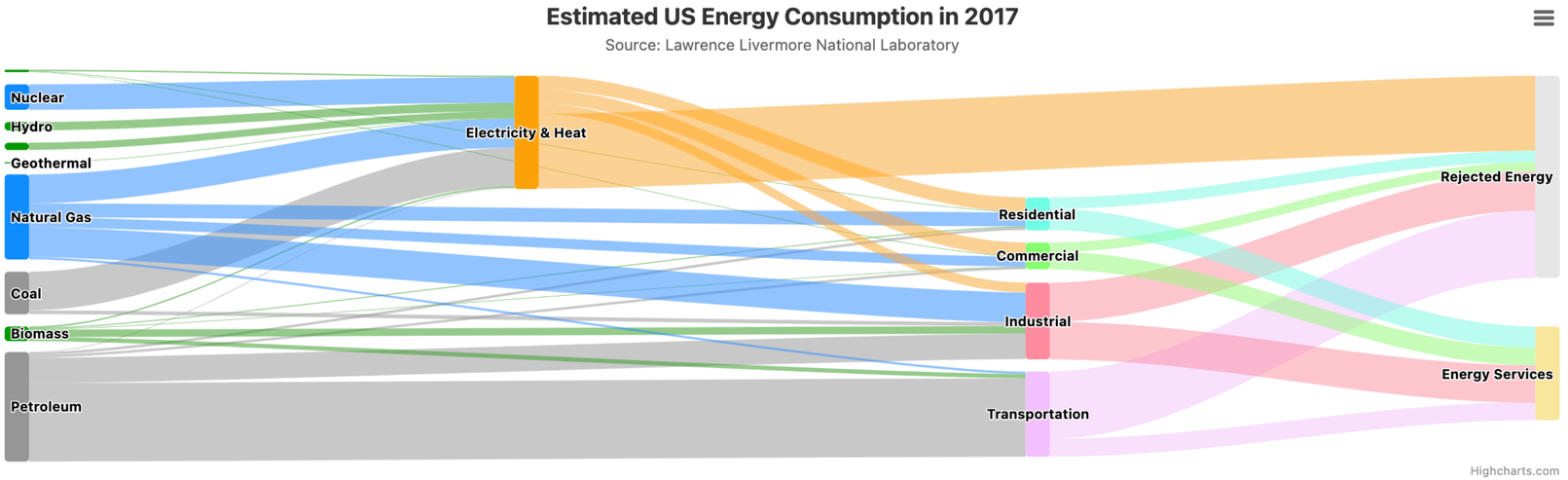


Maybe font size?





Ah, wrong device!



Sankey charts are used to visualize data flow and volume between nodes. The wider lines indicate larger volumes.

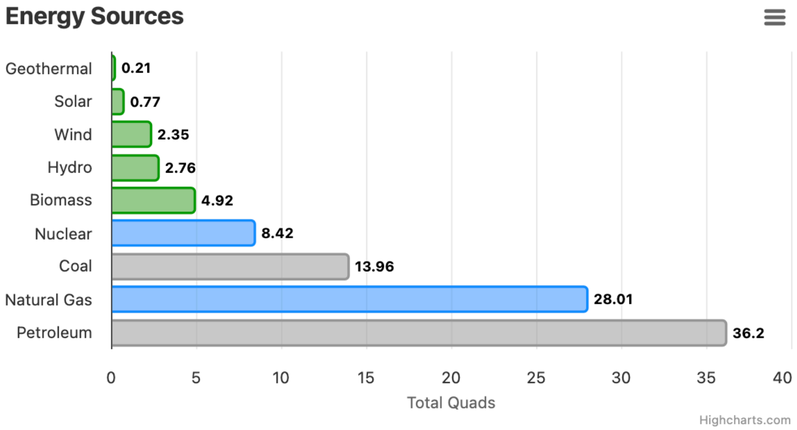
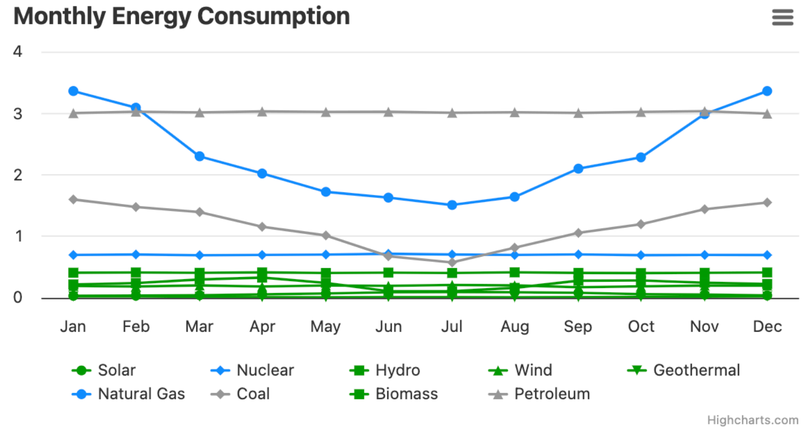


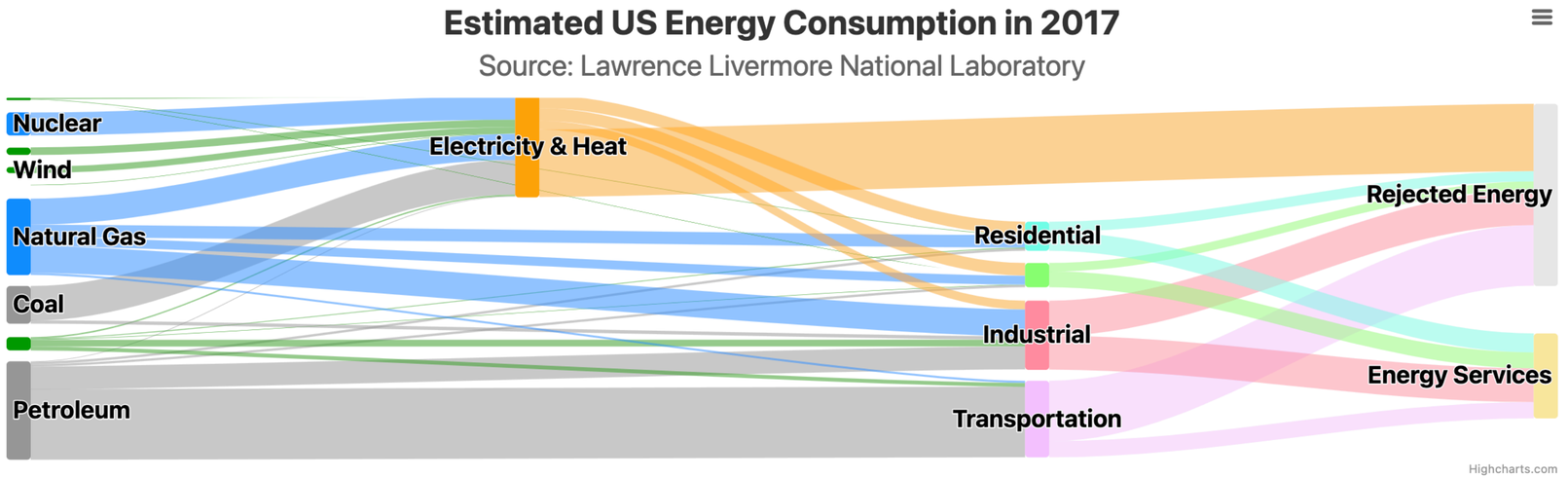
Chart showing stacked columns for comparing quantities. Stacked charts are often used to visualize data that accumulates to a sum.



Line chart for comparing change in data across categories. Line charts are often used to visualize change in data over time, showing important trends. Sonification will play all values selected in legend.

Play chart sonification

A more *presentation-ready* dashboard?



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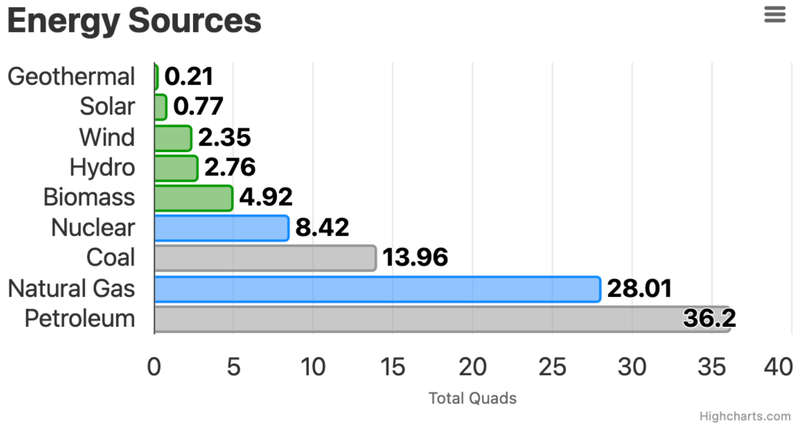

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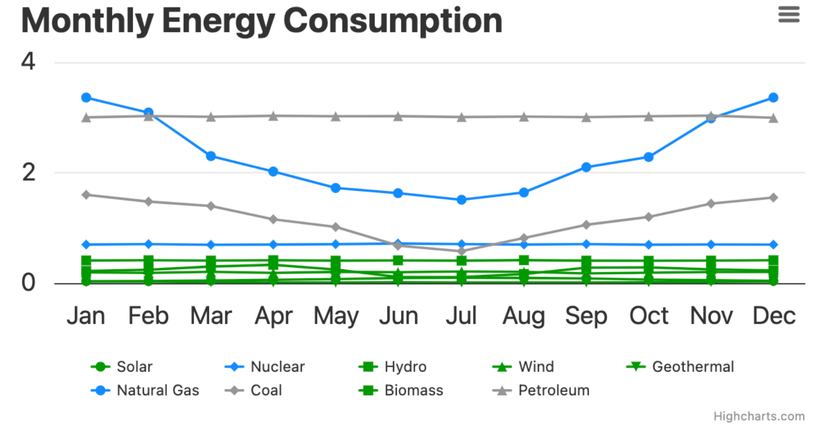

Line chart for comparing change in data across categories. Line charts are often used to visualize change in data over time, showing important trends. Sonification will play all values selected in legend.

Play chart sonification

Situational barriers: inaccessibility due to external context, environment, or conditions

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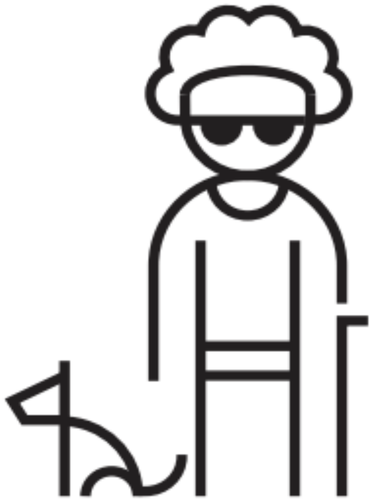
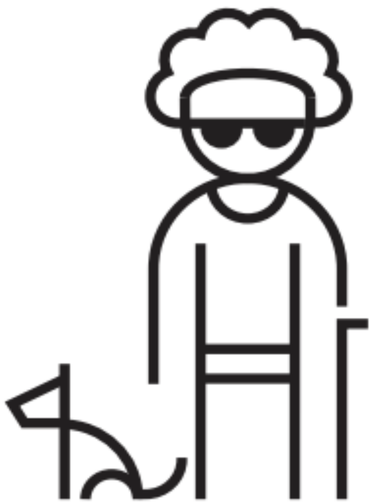
(This design and this device are both barriers if I want to give a good presentation)

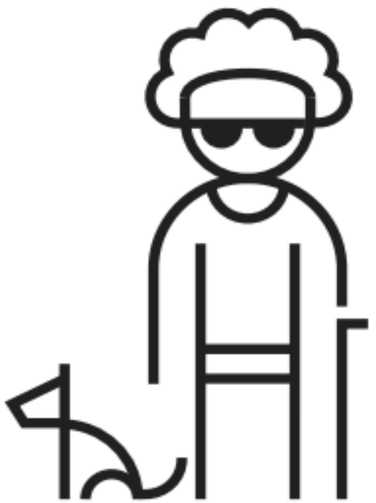
Permanent

See

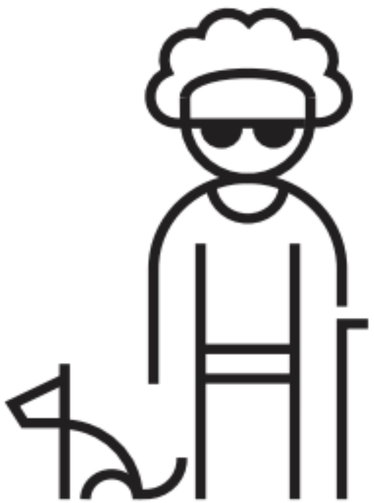


Blind

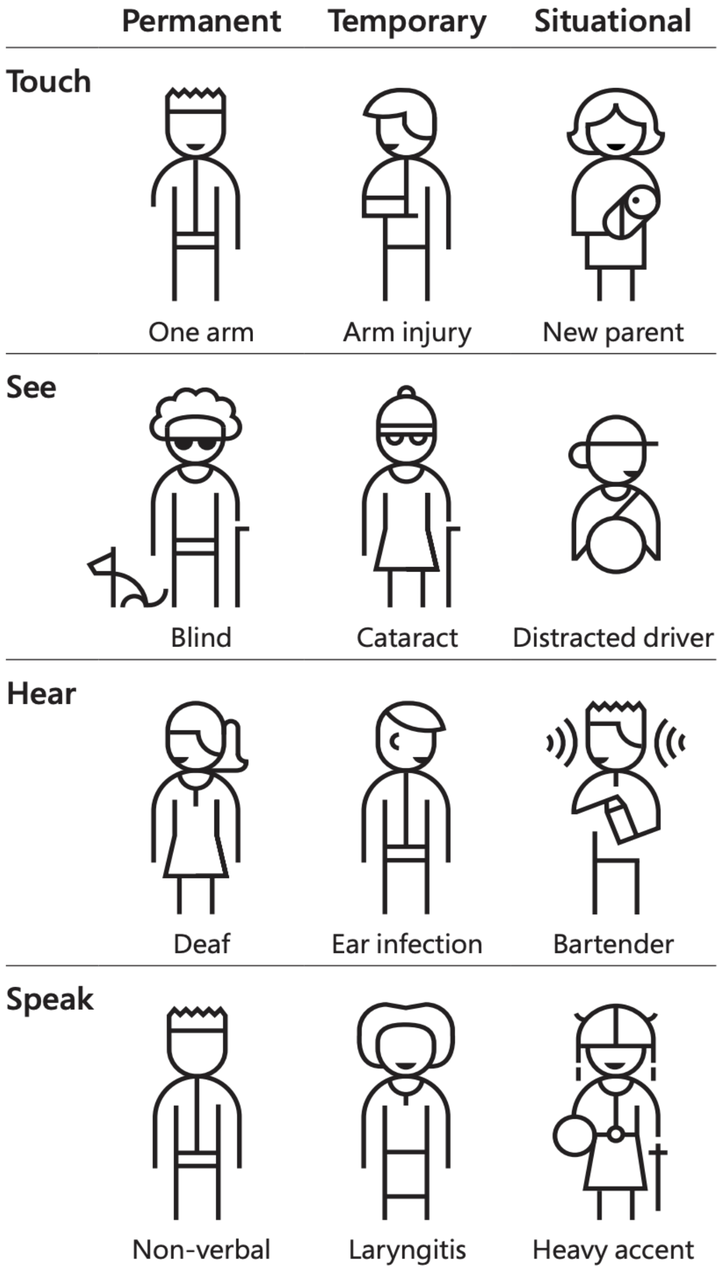
	Permanent	Temporary
See	 Blind	 Cataract

	Permanent	Temporary	Situational
See			
	Blind	Cataract	Distracted driver

Hard-baked, inflexible design creates situational barriers

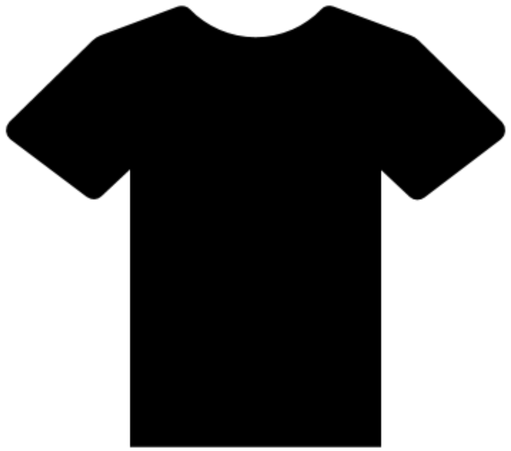
	Permanent	Temporary	Situational
See			
	Blind	Cataract	**“Hard-baked”**

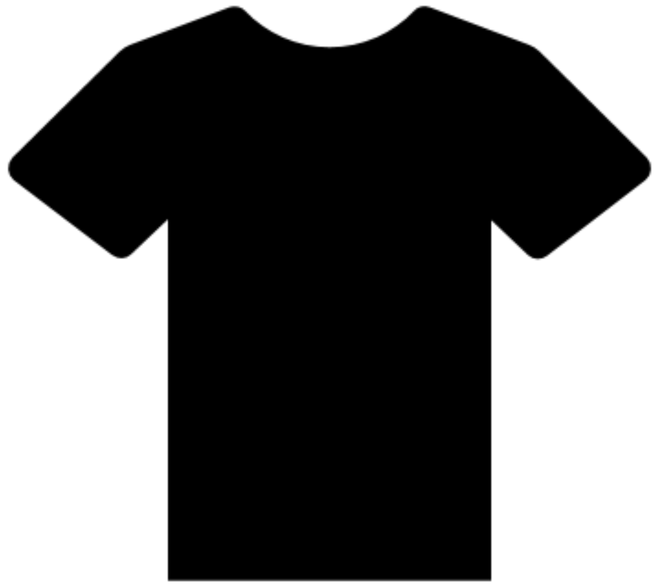
Accessible technology impacts all of us, all the time



Microsoft's Inclusive Design 101 Toolkit: https://download.microsoft.com/download/b/0/d/b0d4bf87-09ce-4417-8f28-d60703d672ed/inclusive_toolkit_manual_final.pdf

Why should our visualizations be one-size-fits-all?





Visualization “software” isn’t *soft* enough.

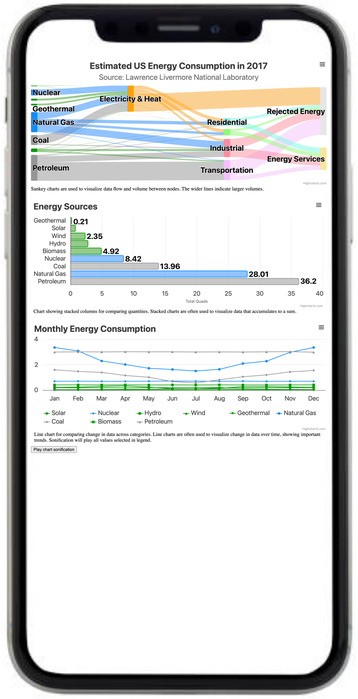
Good visualization isn’t hard-baked, good visualization is *softerware* (responsive and malleable)

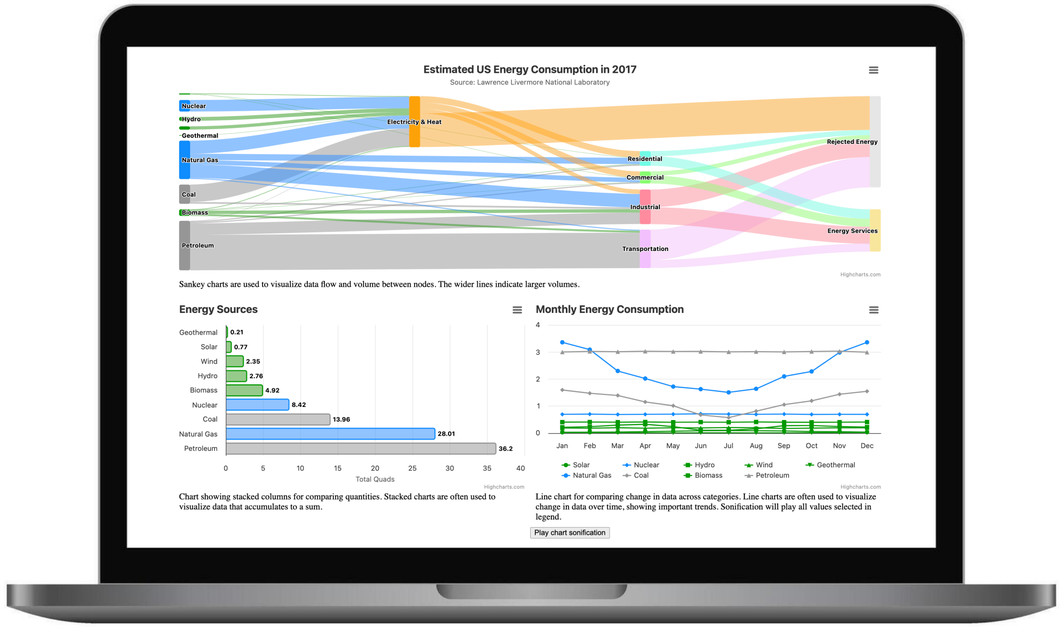
Image source: Research paper by Gandon et al.

Who does repair belong to?

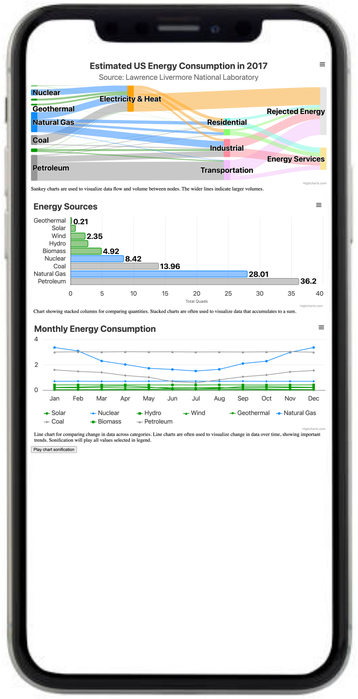
Portland's "Anarchist Road Repair," Credit: Bloomberg

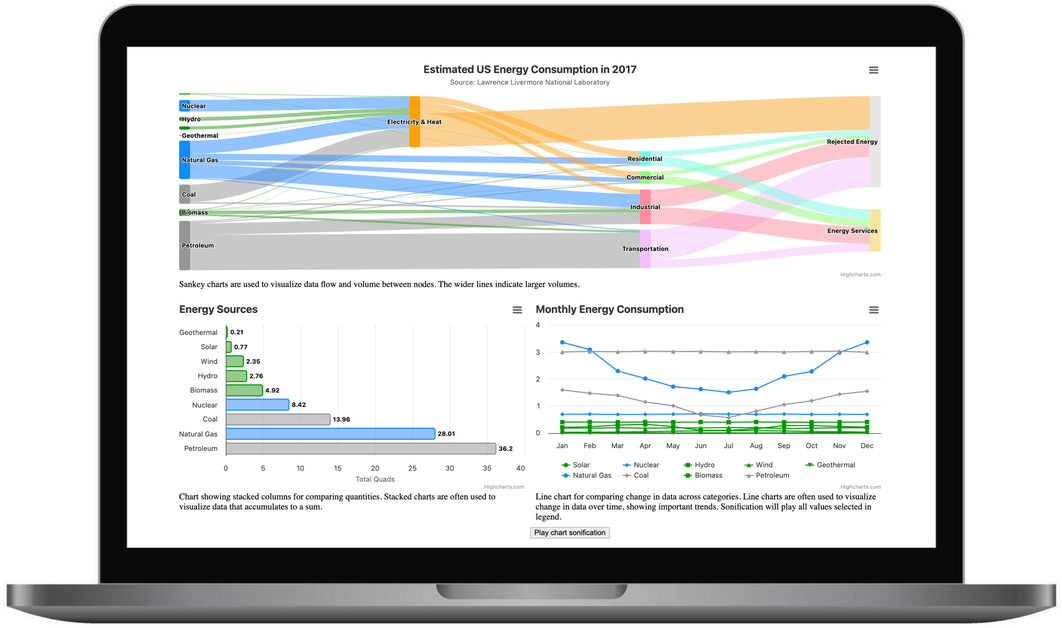
The way we design visualizations should be *responsive* and *malleable*.

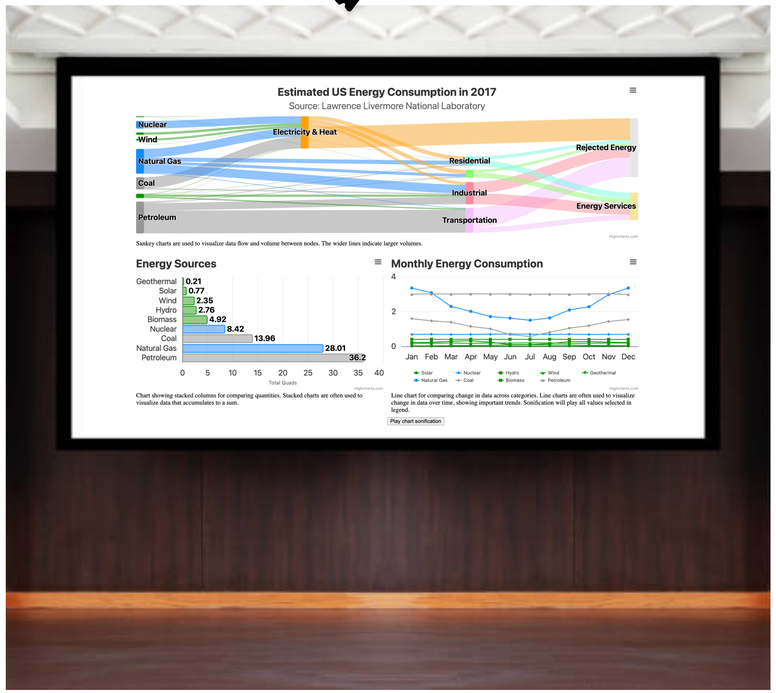




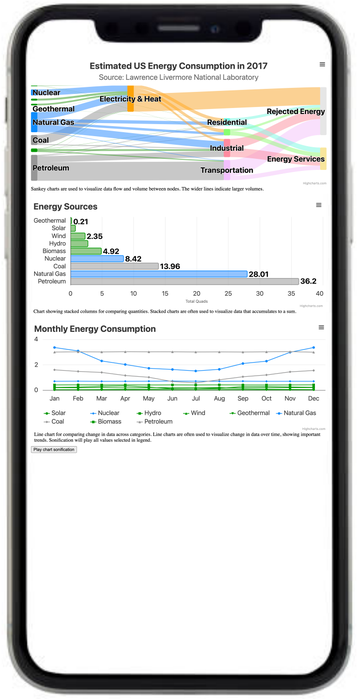
Responsive visualizations aren't enough

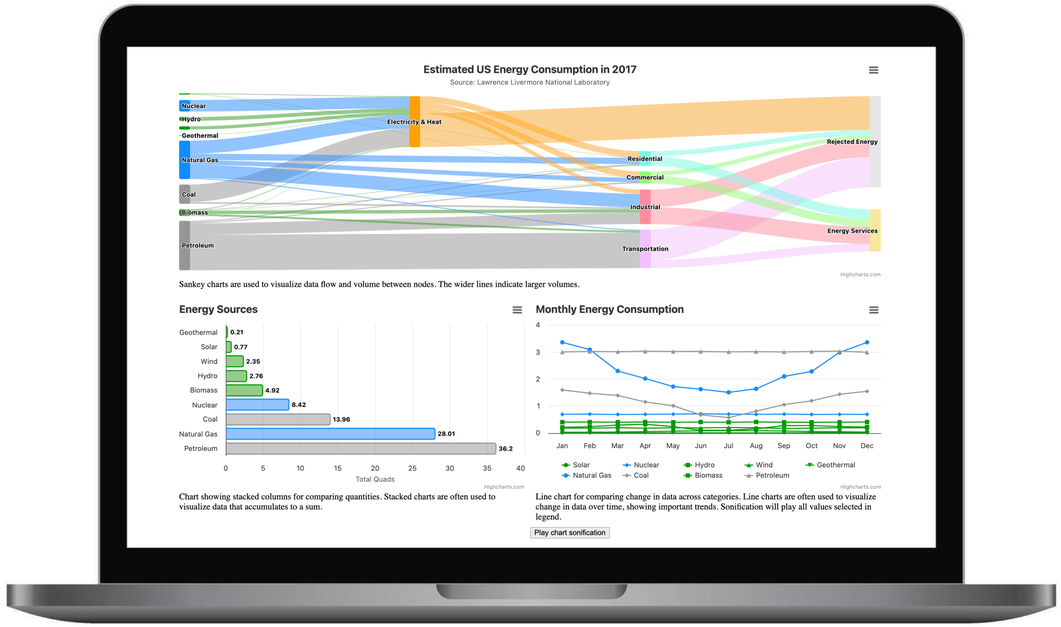




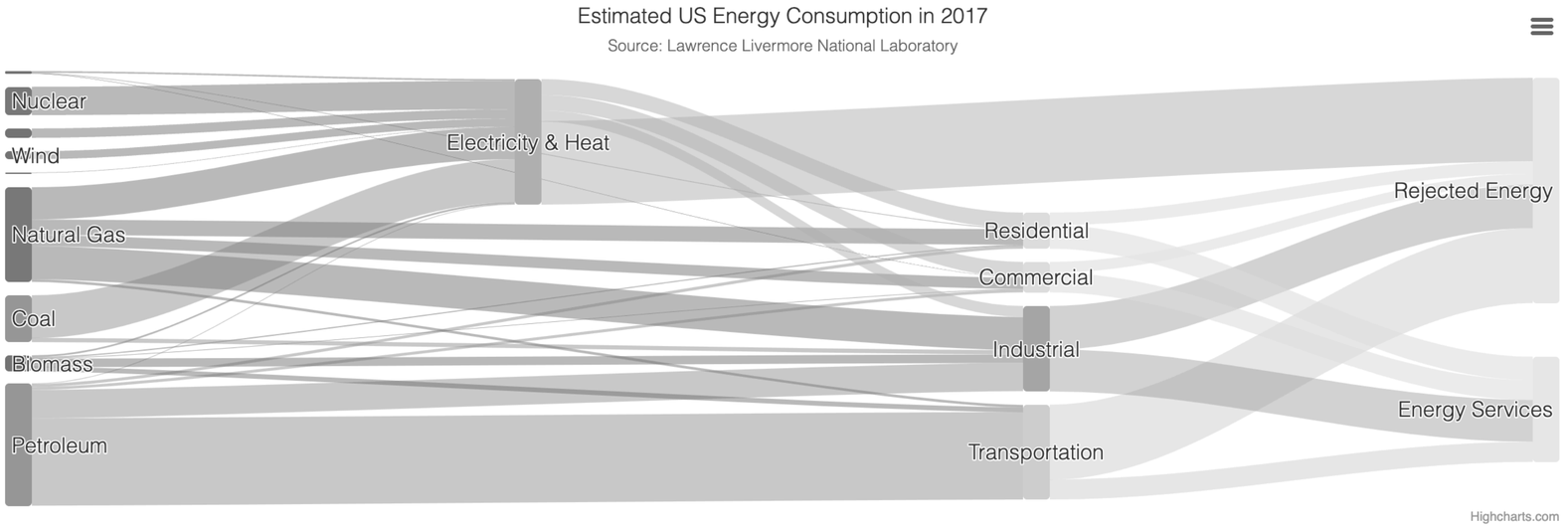


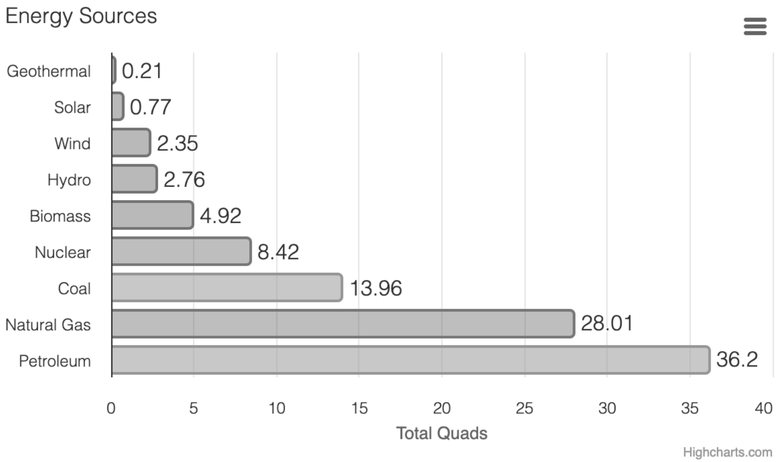
Sometimes, only the user knows what design is best

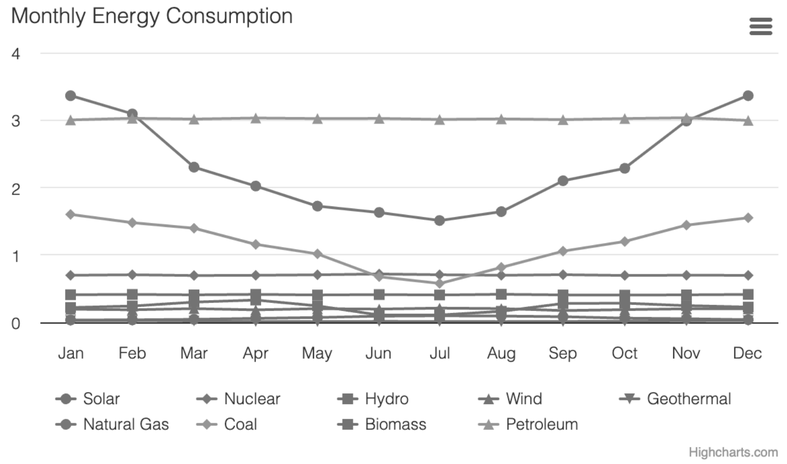




What does it mean for a visualization to be *malleable*?

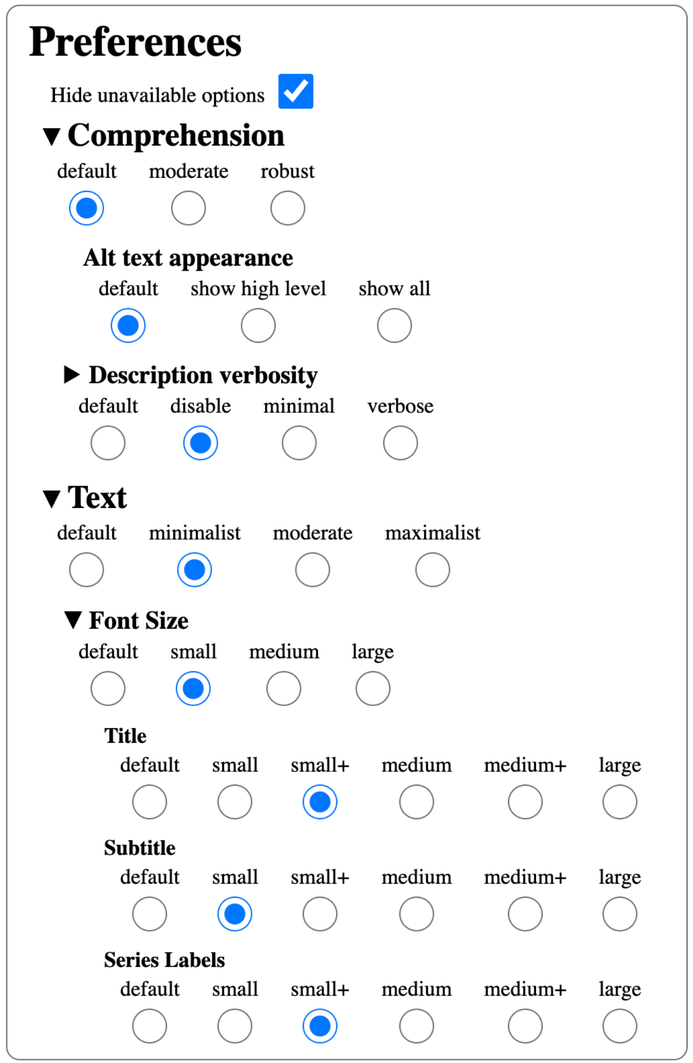


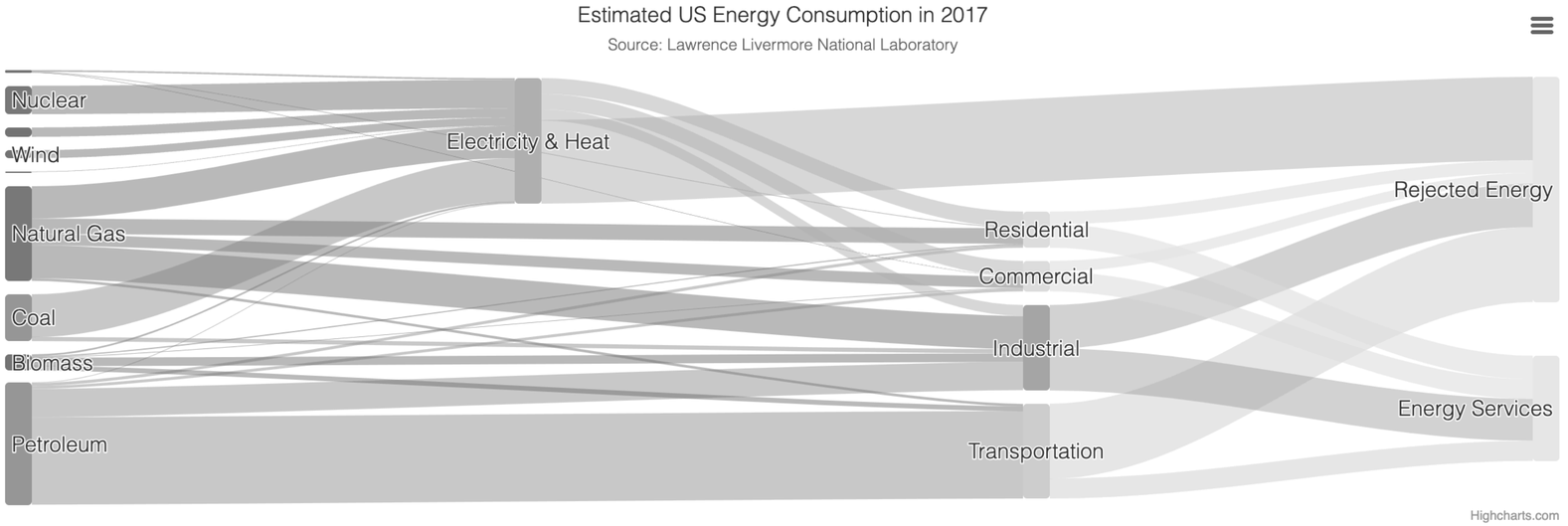


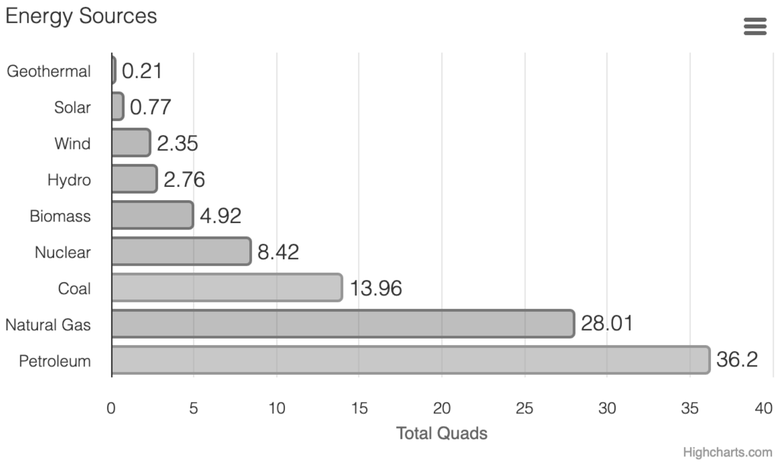


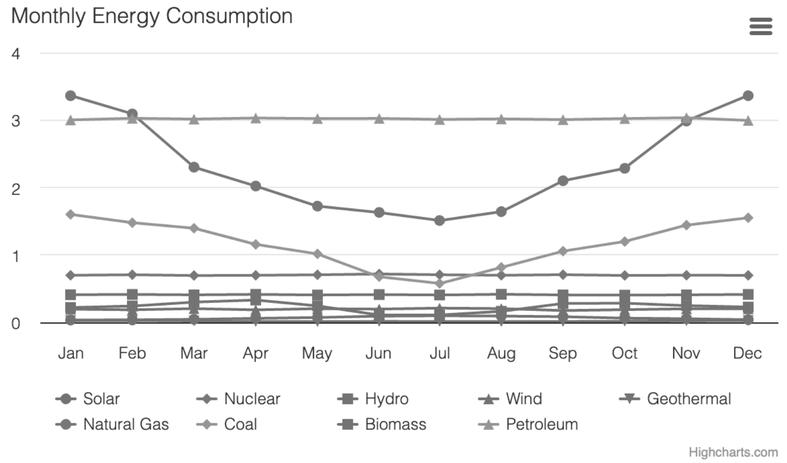
Interactive demo link

We should let users *personalize* visualizations









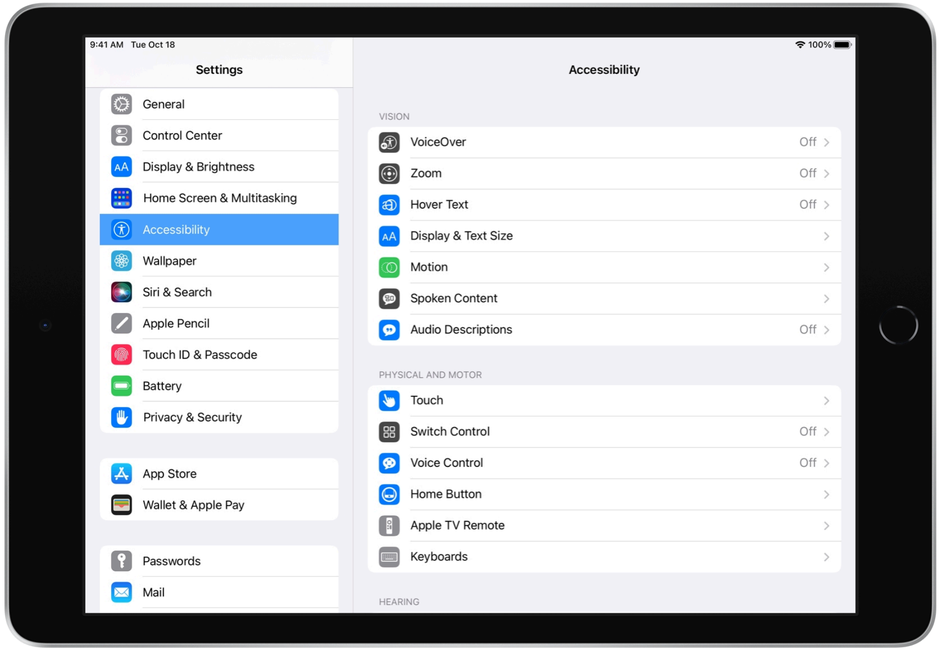
Interactive demo link

We have been enabling personalization for years

Video games

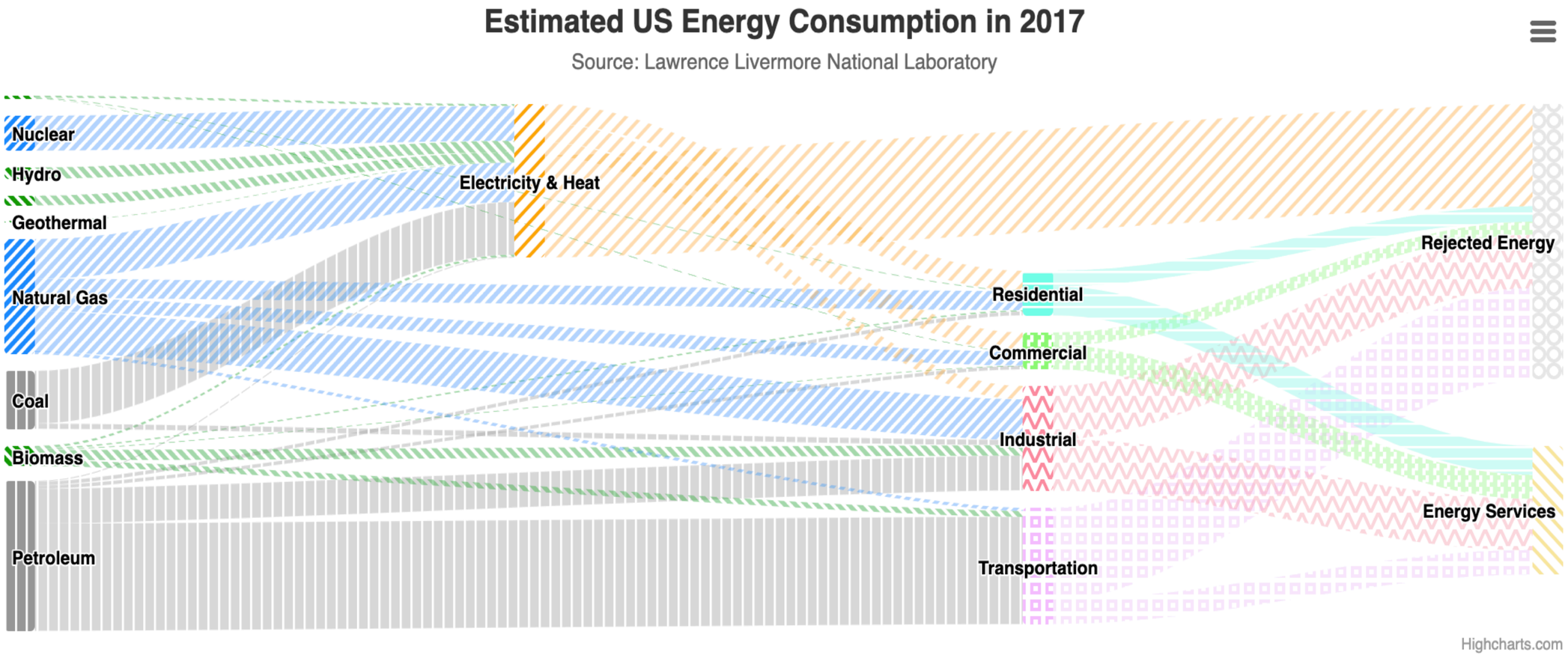
[The Last of Us 2 has more than 60 settings]

Devices and operating systems



"[Make it yours]" is the motto for Apple's accessibility personalization

What about this visualization might be a barrier?



Sankey charts are used to visualize data flow and volume between nodes. The wider lines indicate larger volumes.

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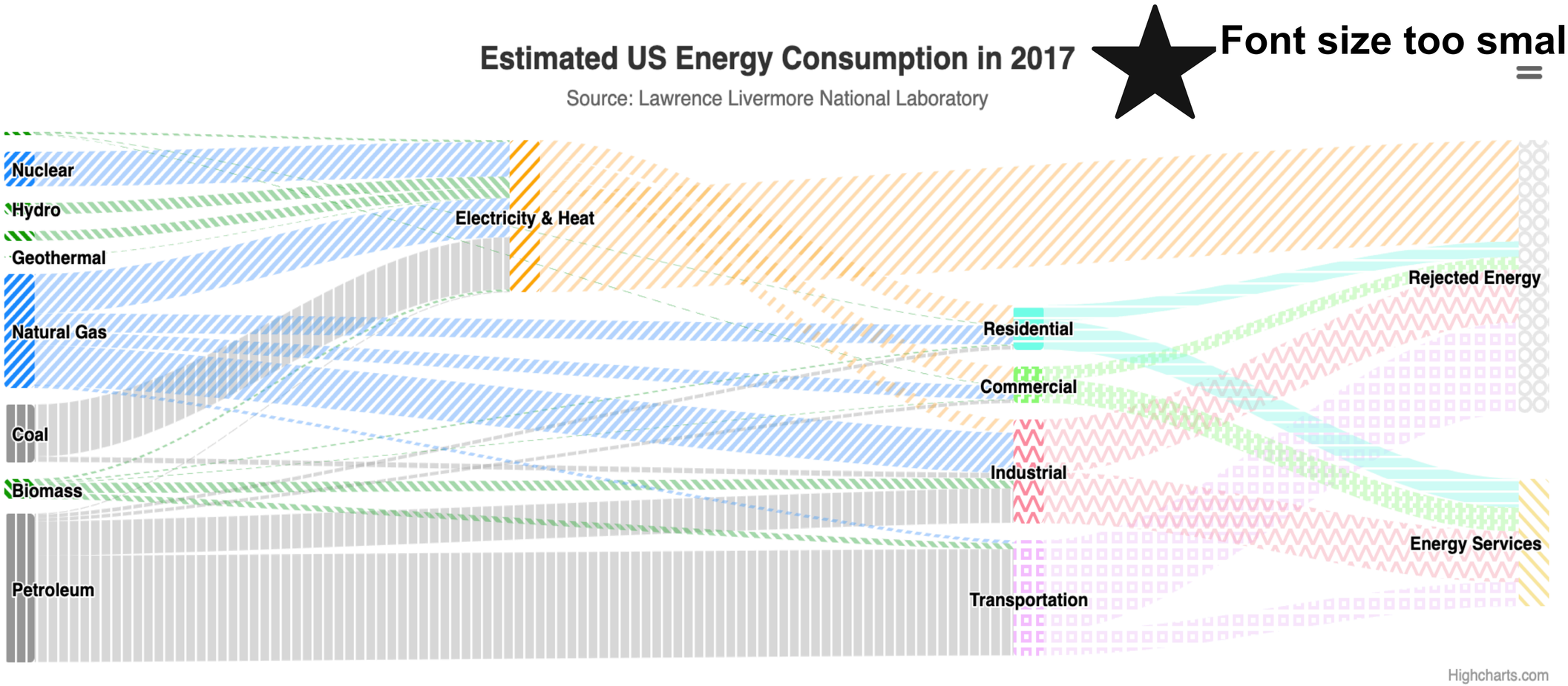

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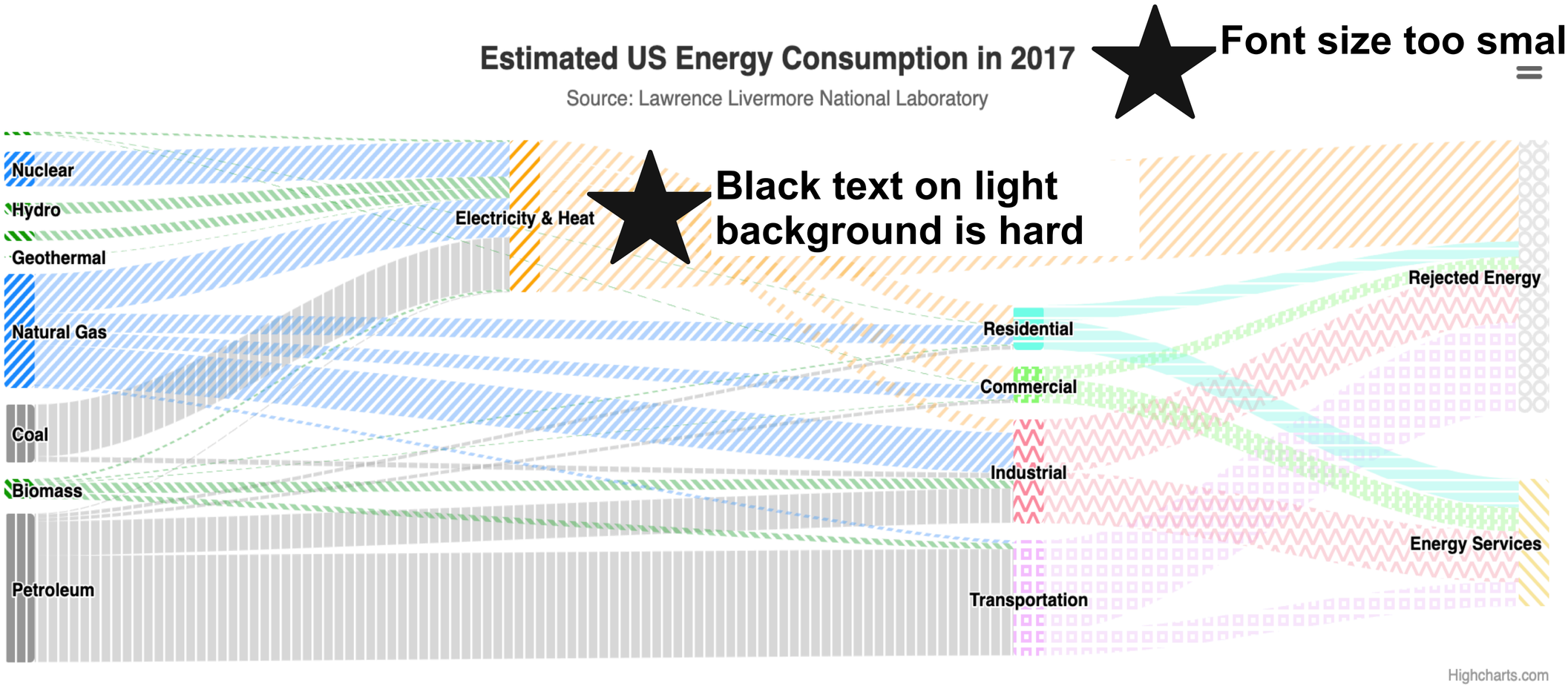

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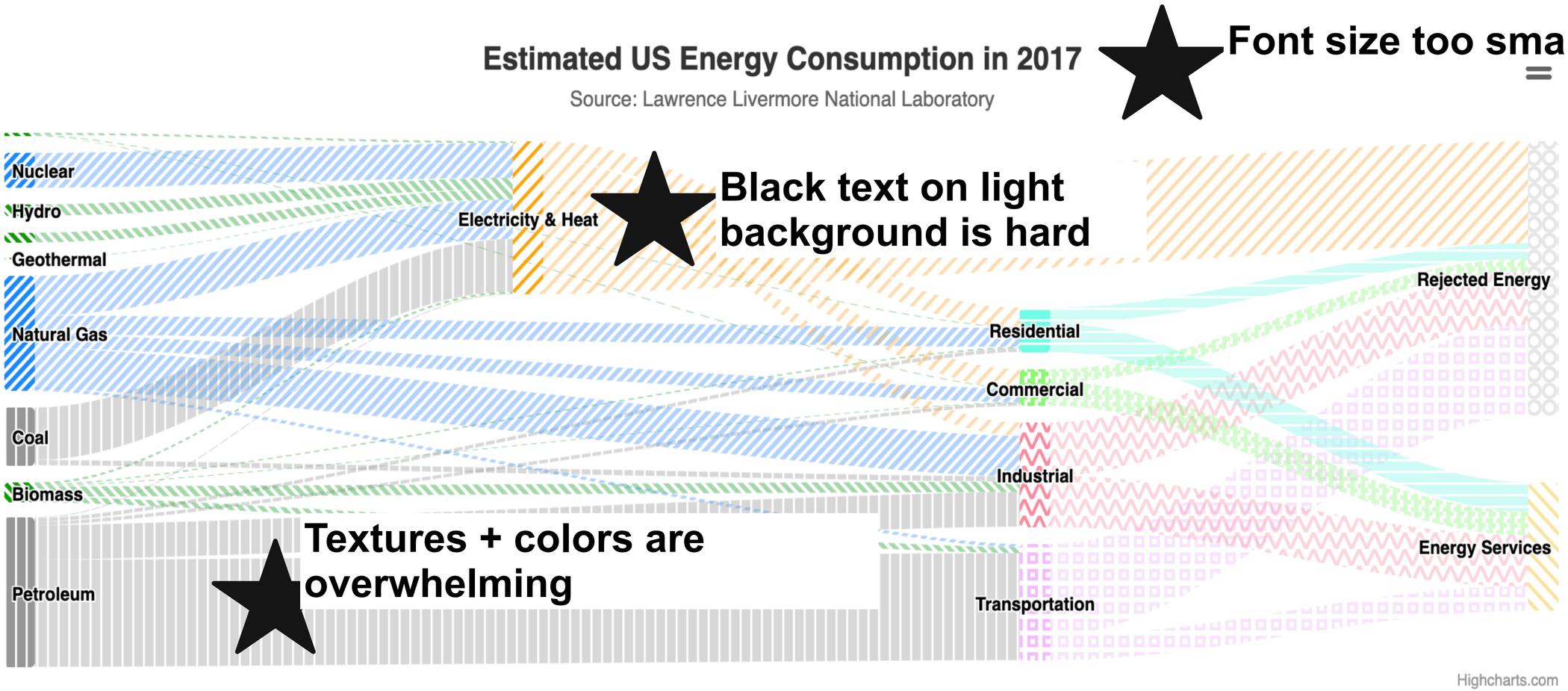

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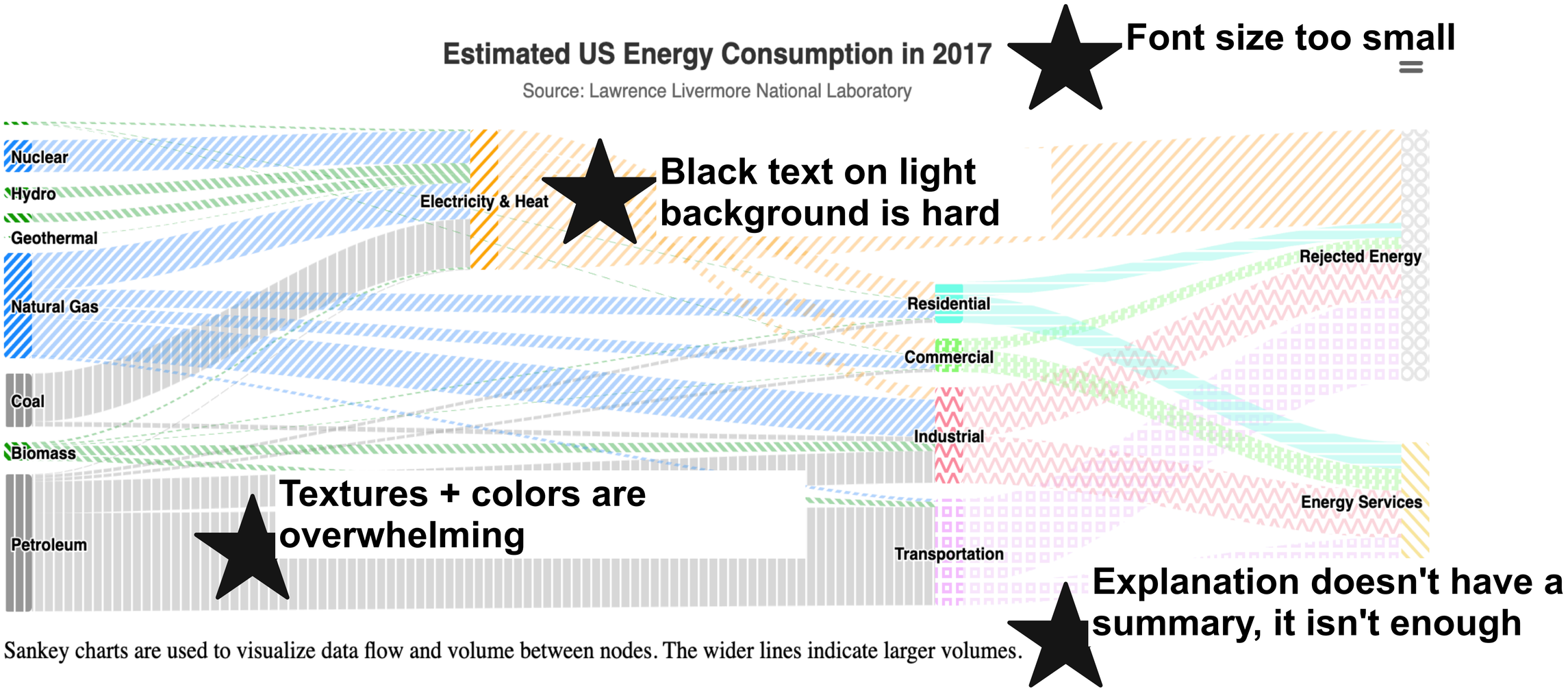
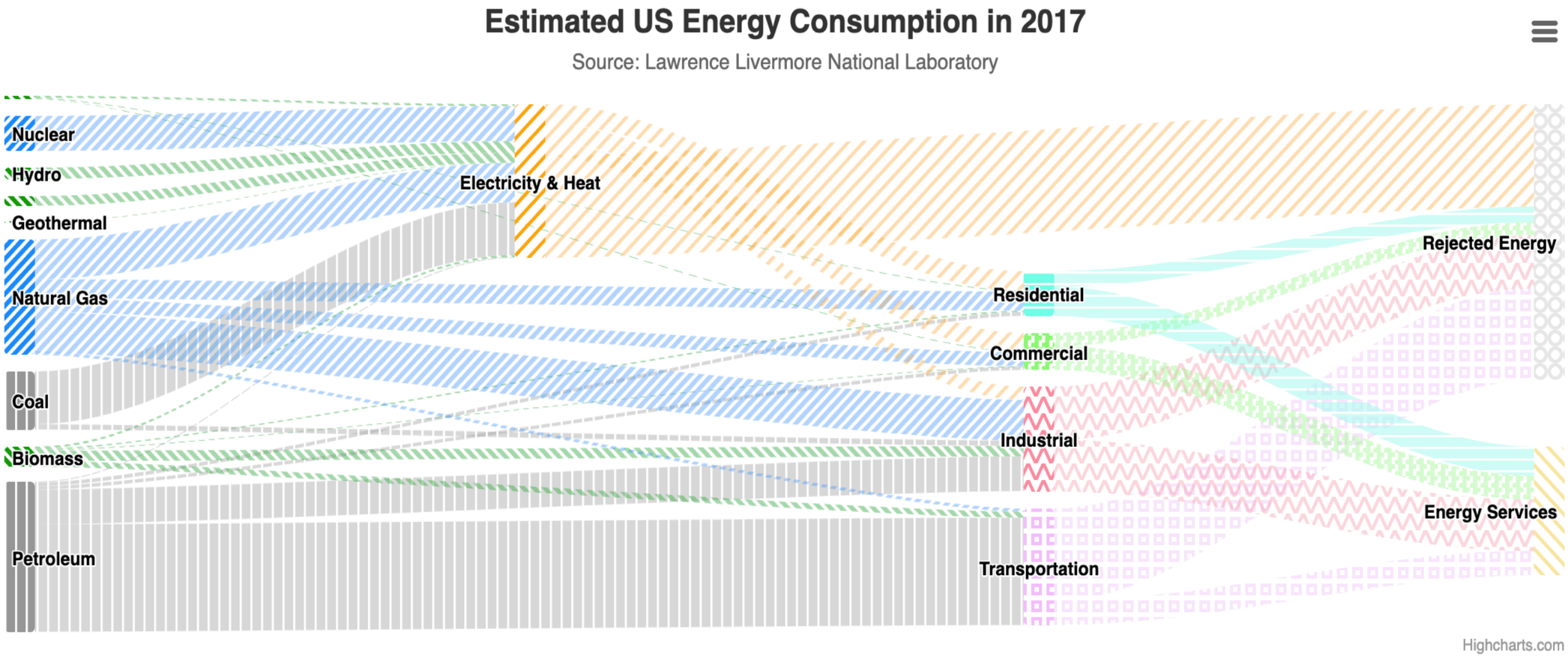
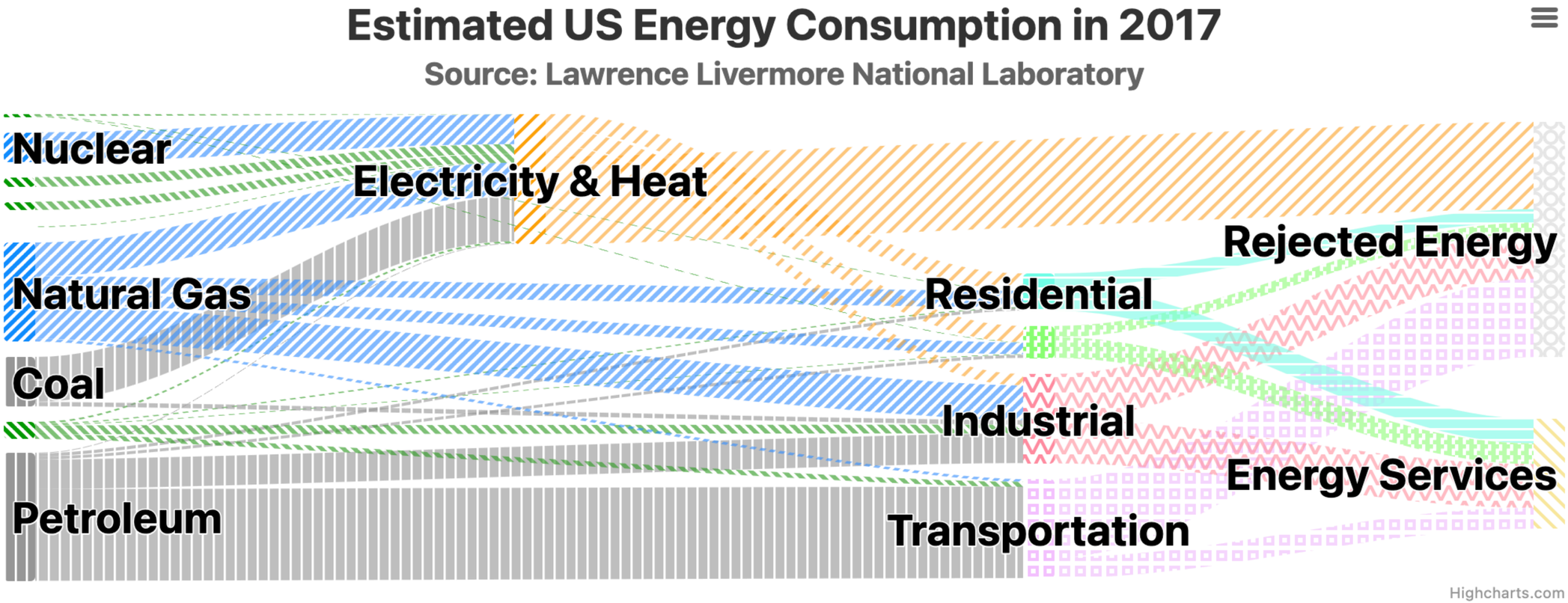


Can we fix this?



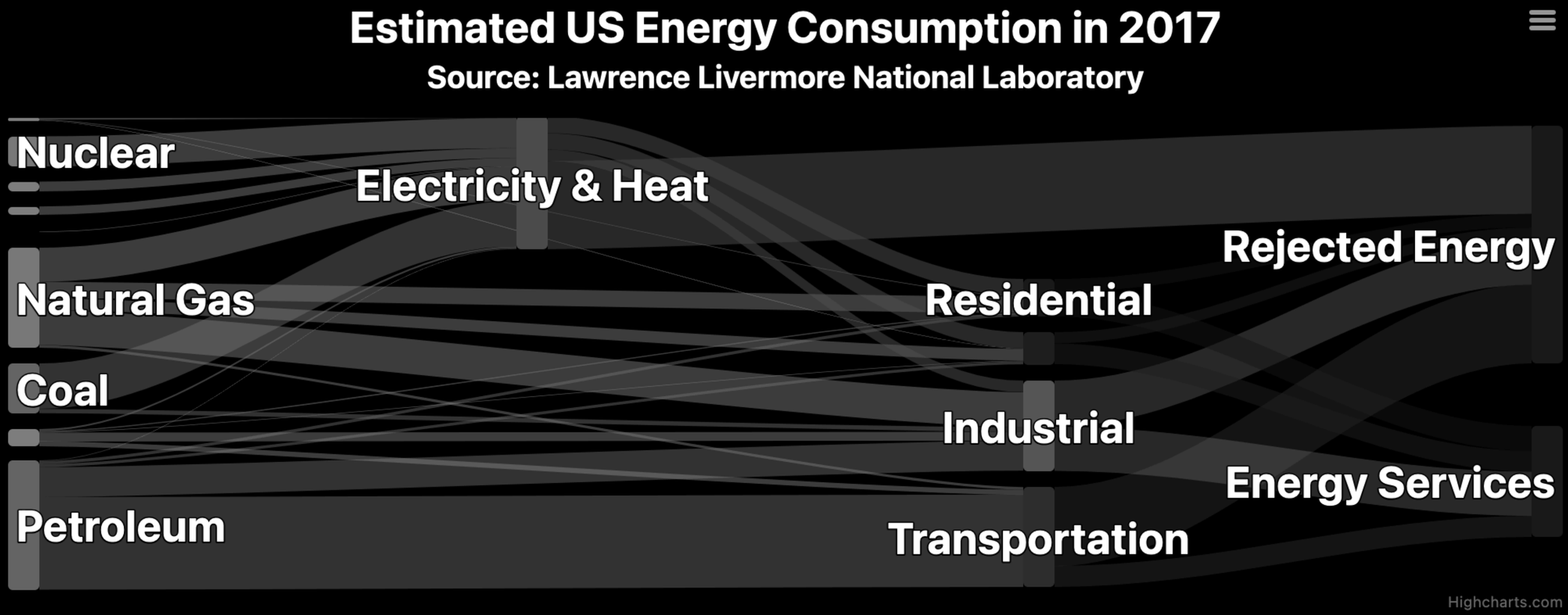
Sankey charts are used to visualize data flow and volume between nodes. The wider lines indicate larger volumes.

Maybe we can bump up the text size



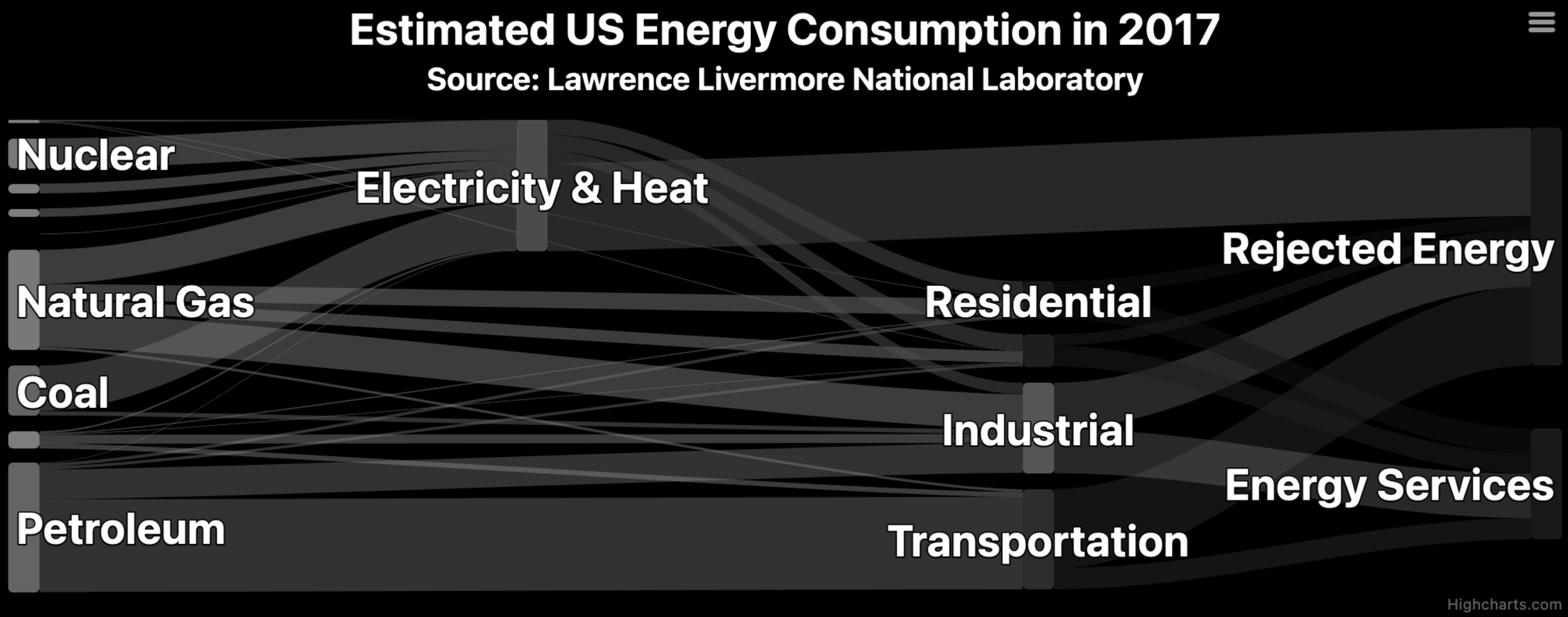
Sankey charts are used to visualize data flow and volume between nodes. The wider lines indicate larger volumes.

We can reduce visual complexity too



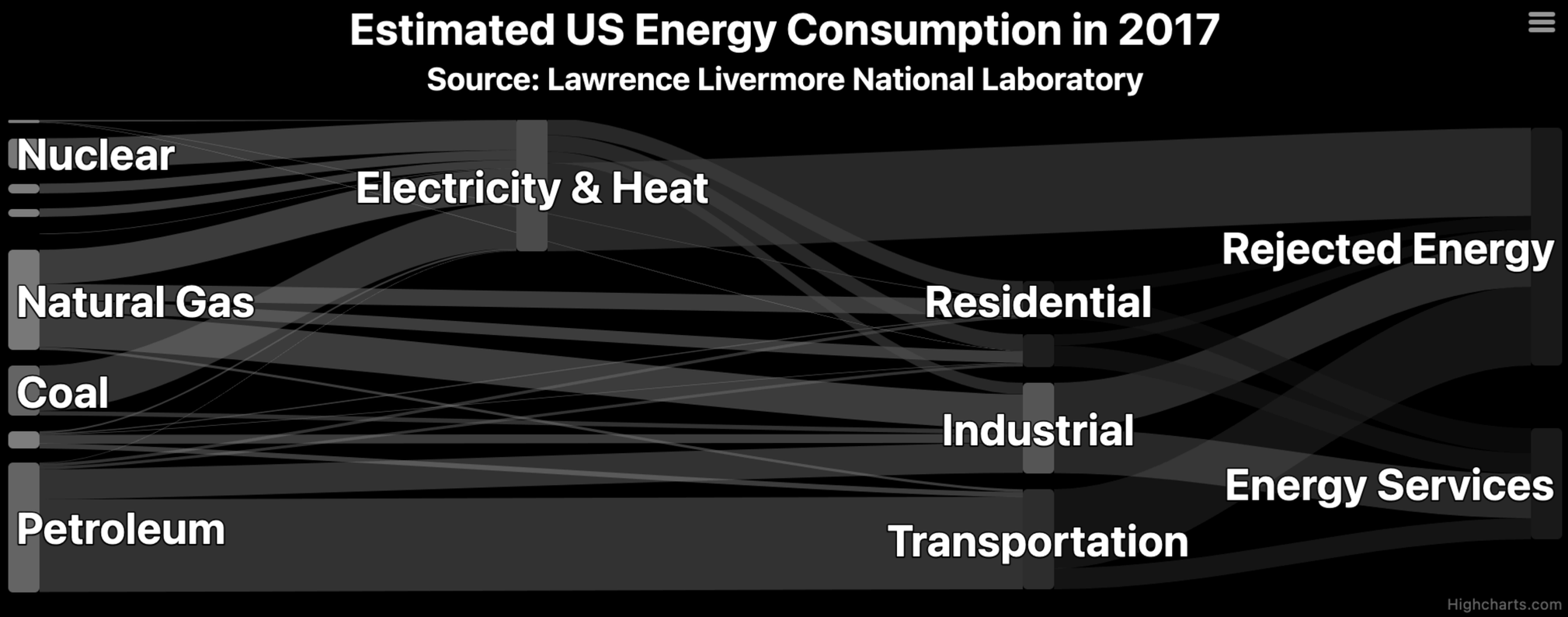
Sankey charts are used to visualize data flow and volume between nodes. The wider lines indicate larger volumes.

We can add a more descriptive explanation



Sankey charts are used to visualize data flow and volume between nodes. Visually wider lines indicate larger volumes. This chart is showing energy consumption and types. Interacting with this chart by selecting a node or flow (such as with a click) will update the stacked bar chart below.

Is this the *perfect*, most accessible design?



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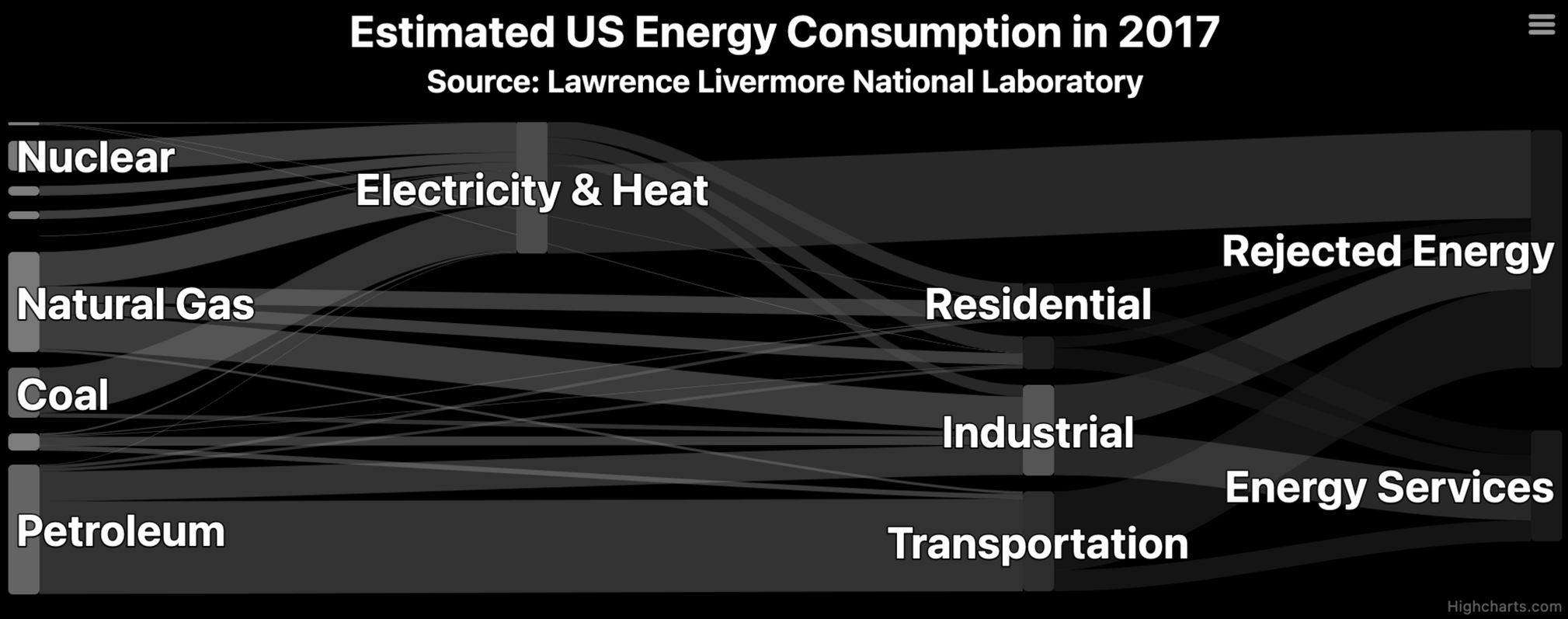
Bad news...

This design has accessibility issues too



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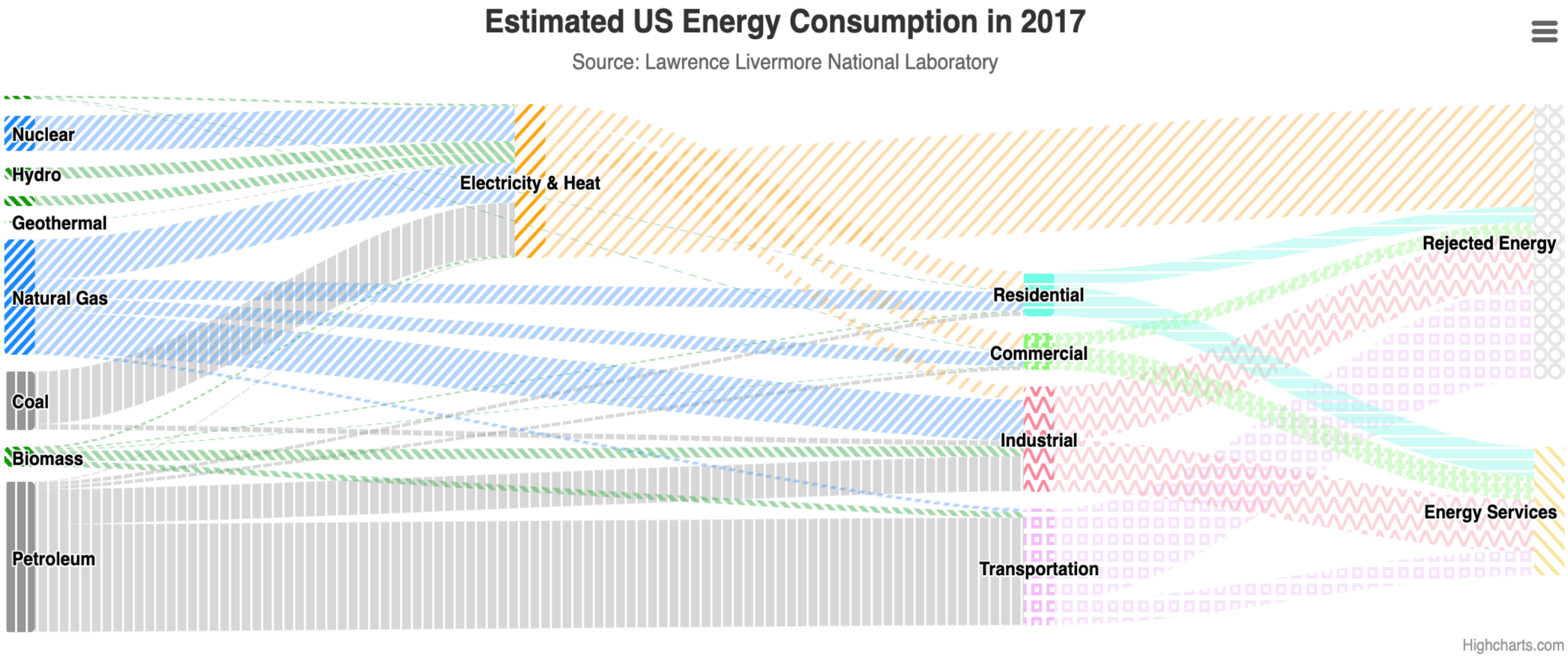
There is no such thing as a single, perfect visualization



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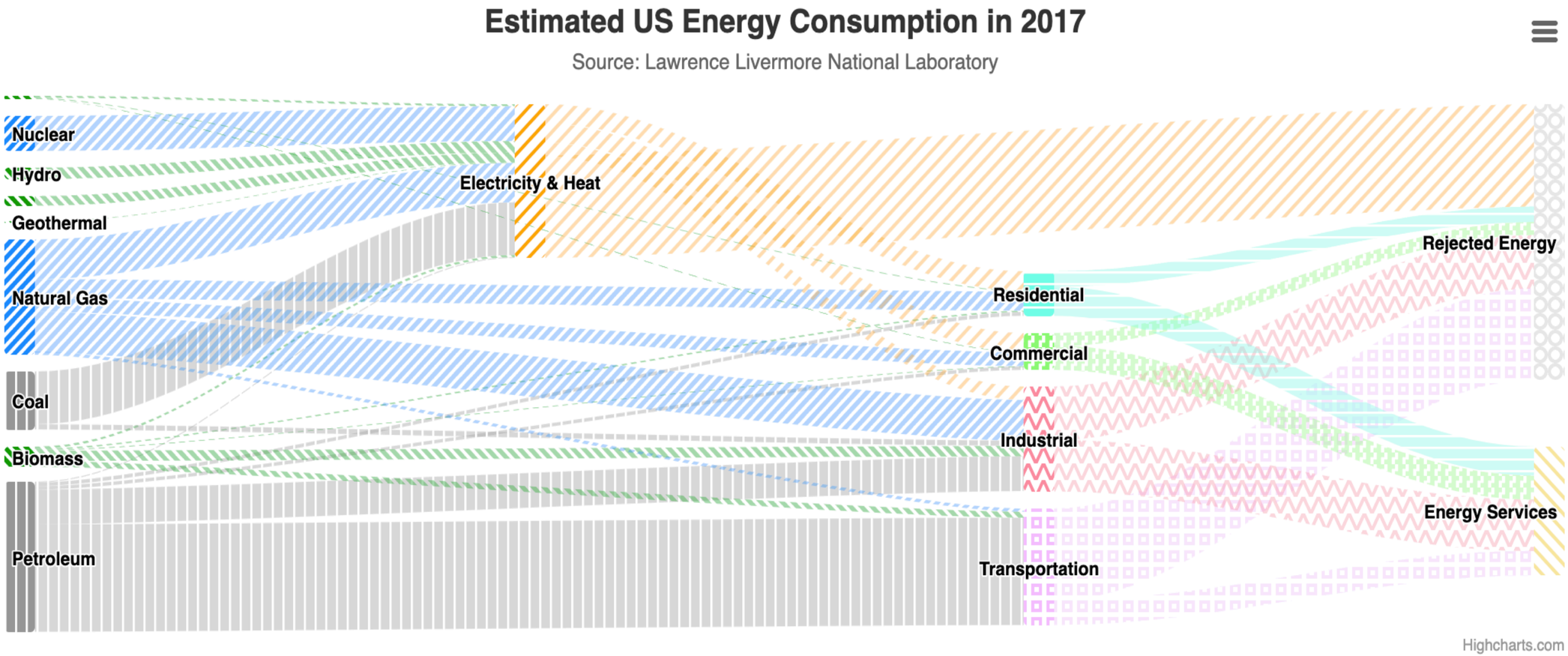
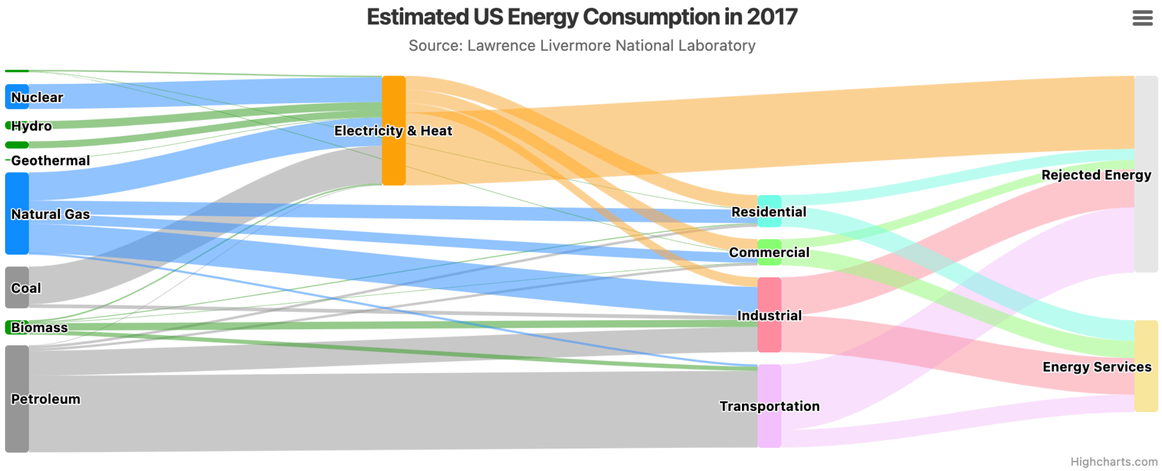
One design *cannot* fit all



Sankey charts are used to visualize data flow and volume between nodes. The wider lines indicate larger volumes.

We explored how people with disabilities personalize



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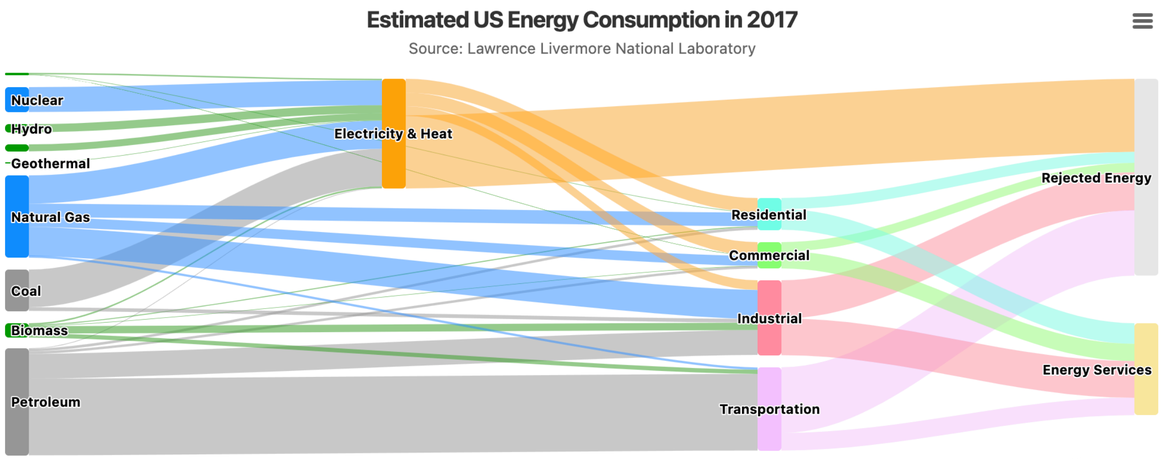
Low vision: All wanted bigger text



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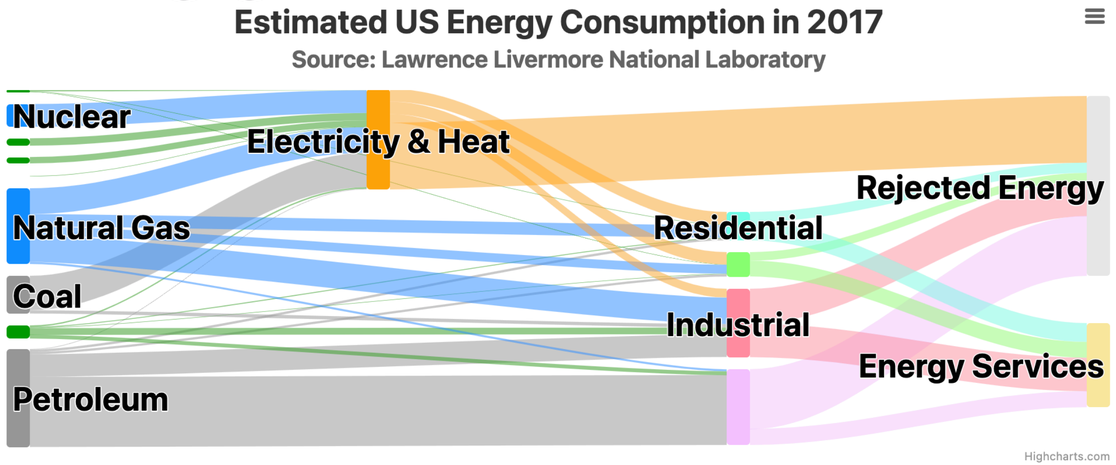

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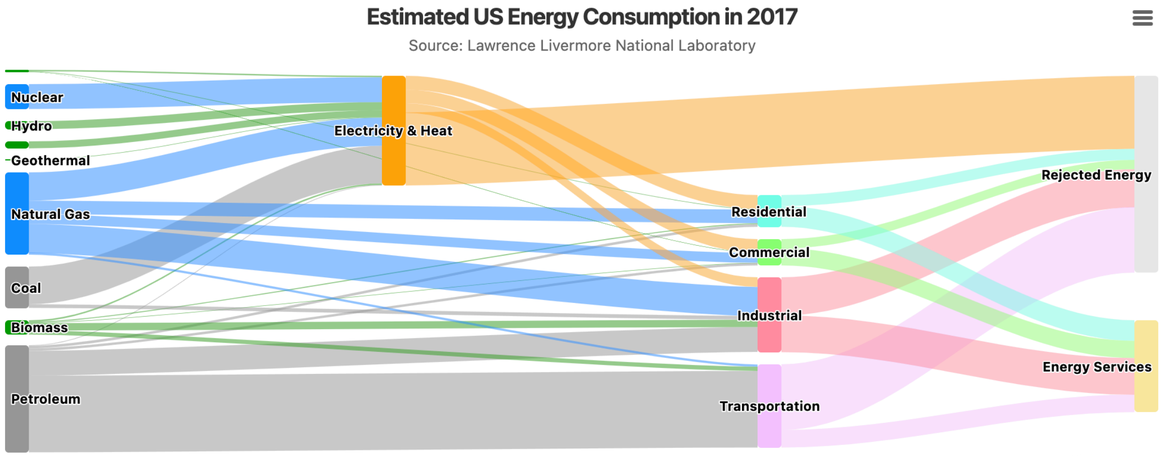
Some want patterns



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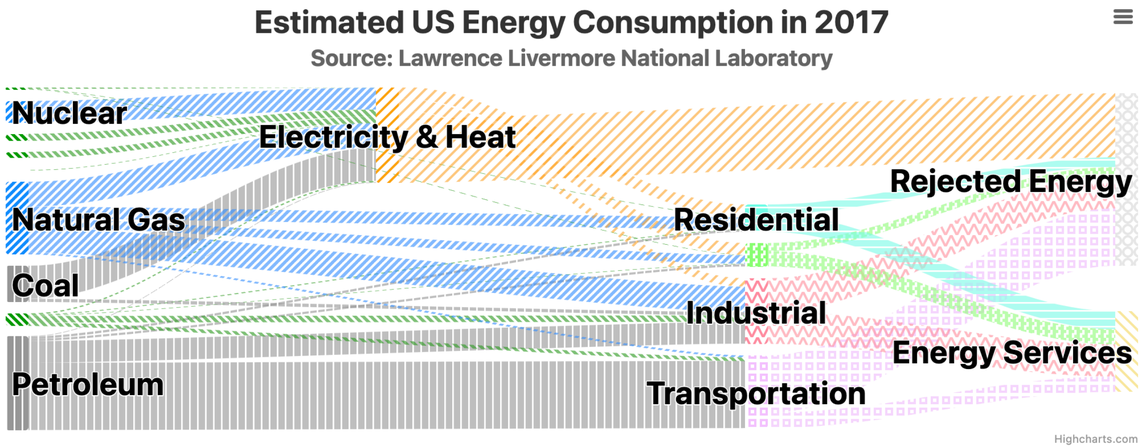

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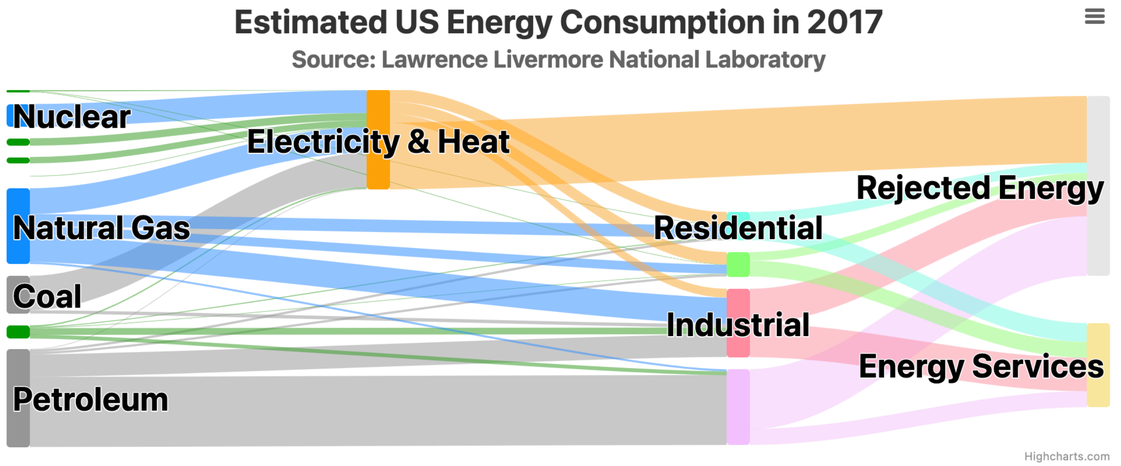
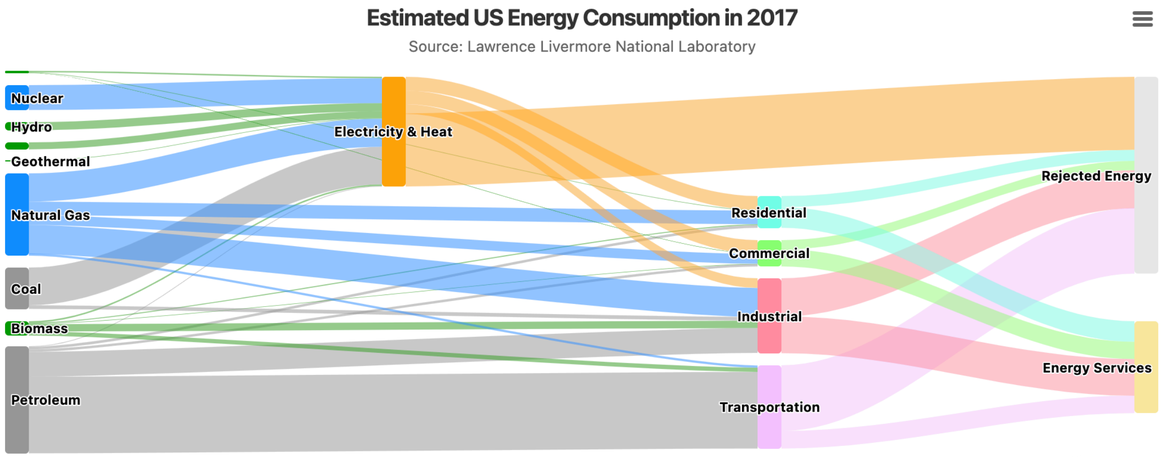
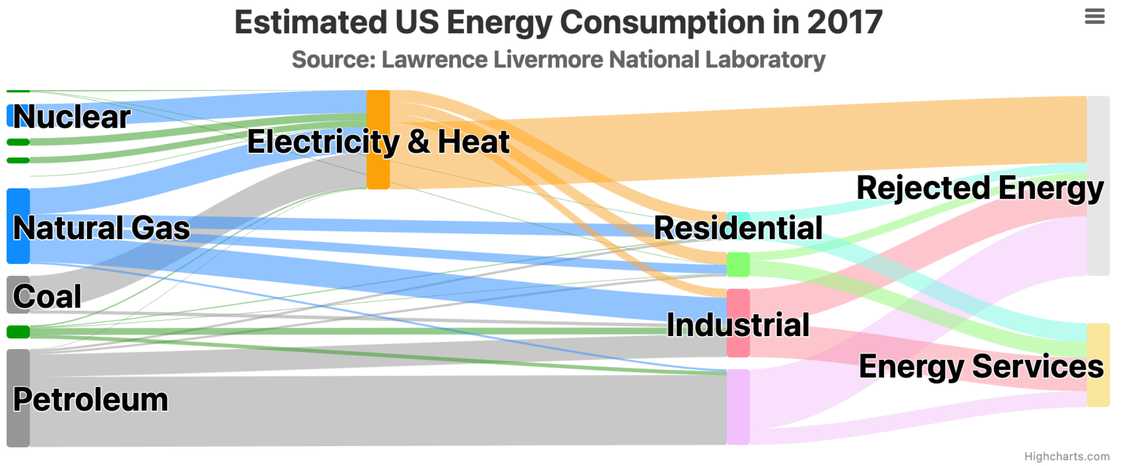


Sankey charts are used to visualize data flow and volume between nodes. The wider lines indicate larger volumes.

Others wanted dark mode and minimalist



Sankey charts are used to visualize data flow and volume between nodes. The wider lines indicate larger volumes.



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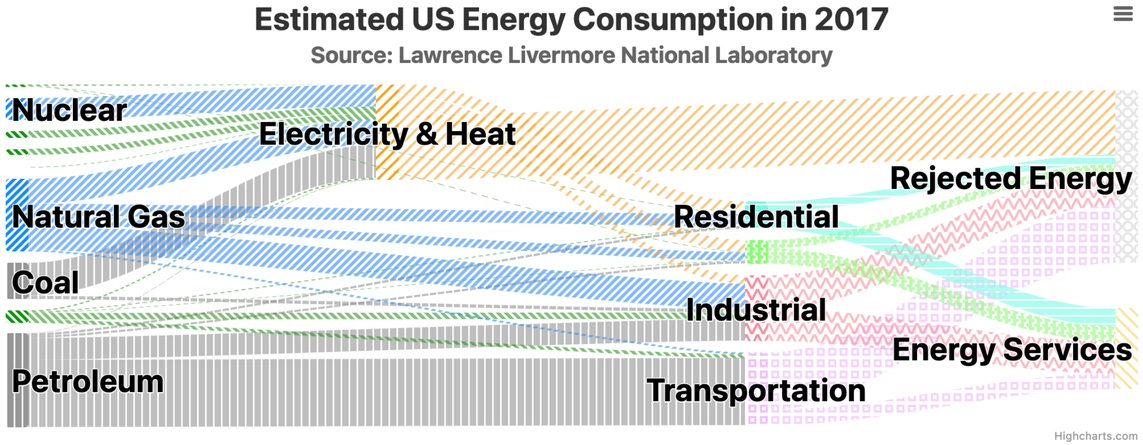

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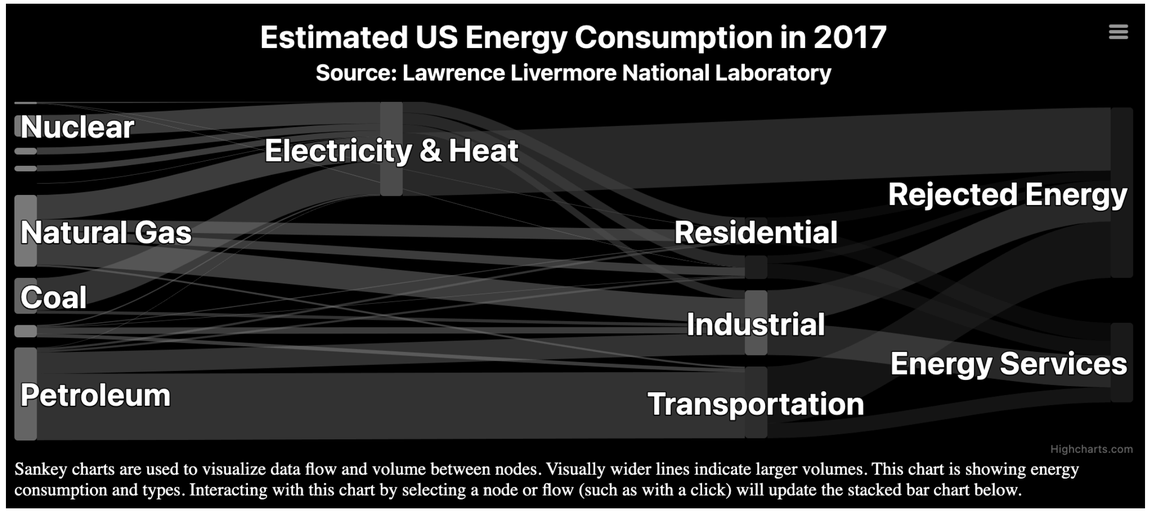
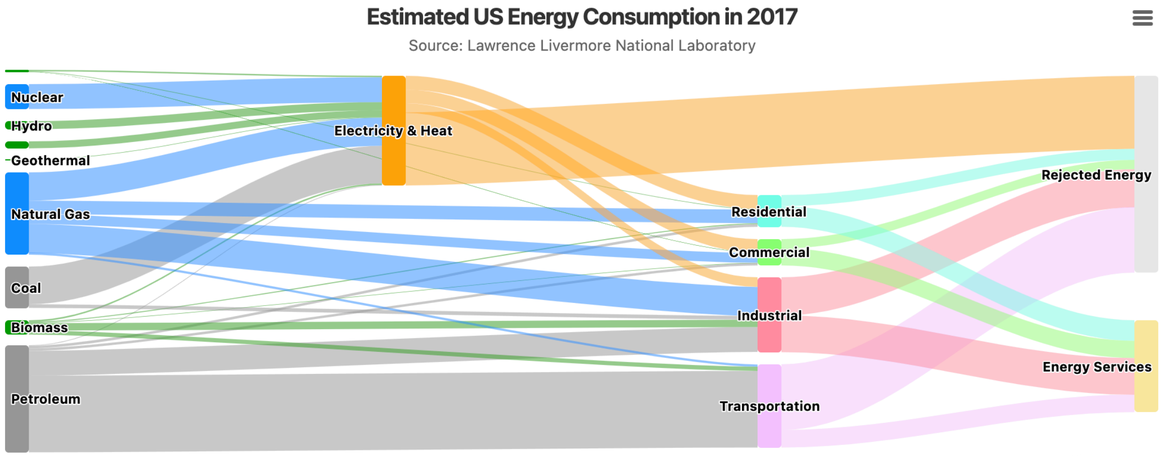


Sankey charts are used to visualize data flow and volume between nodes. Visually wider lines indicate larger volumes. This chart is showing energy consumption and types. Interacting with this chart by selecting a node or flow (such as with a click) will update the stacked bar chart below.

These designs are all “access frictions”



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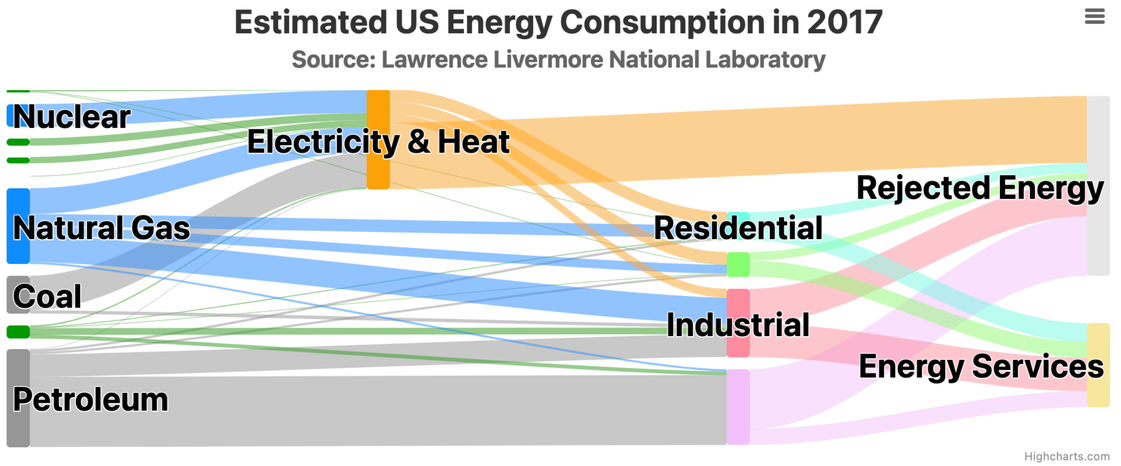

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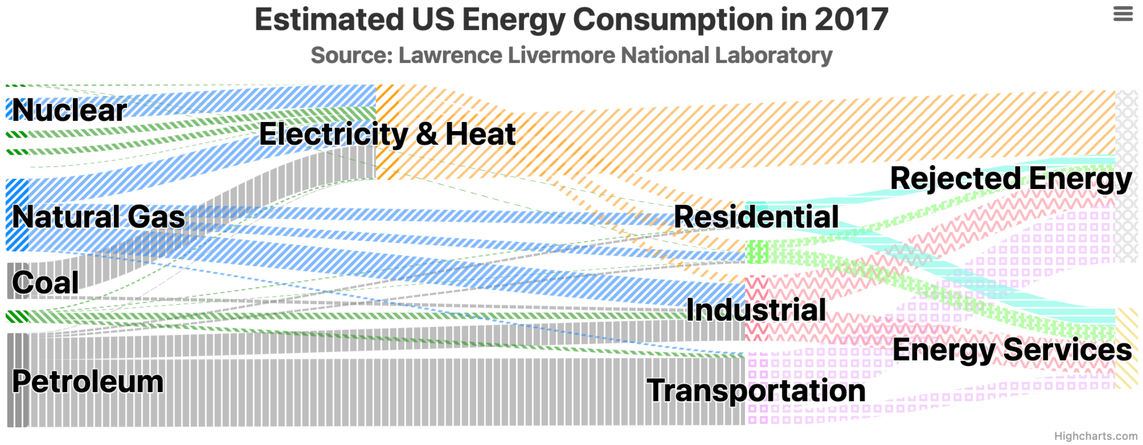

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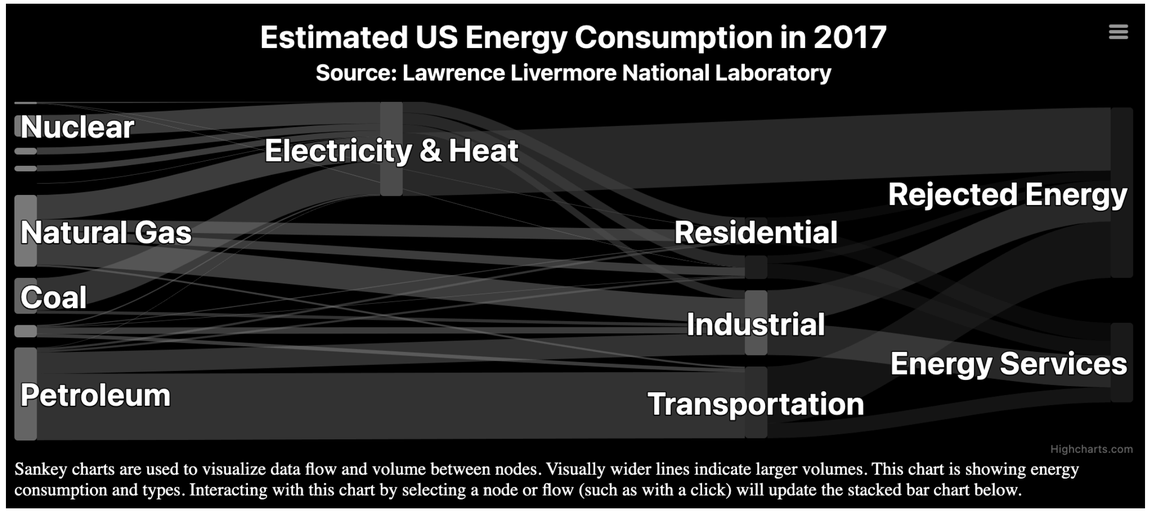

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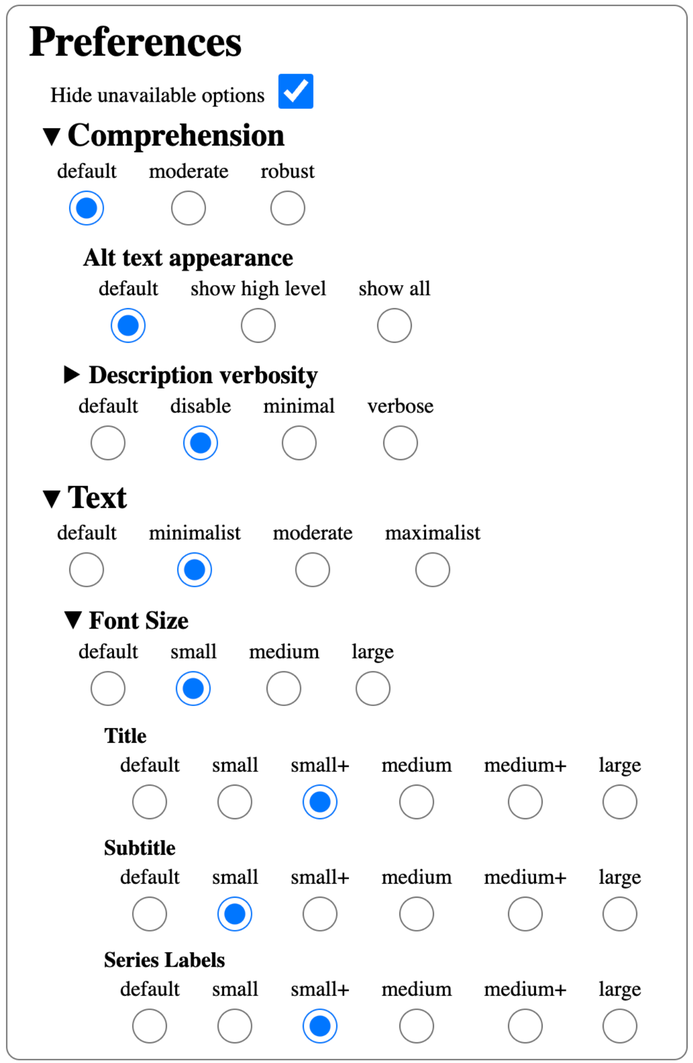
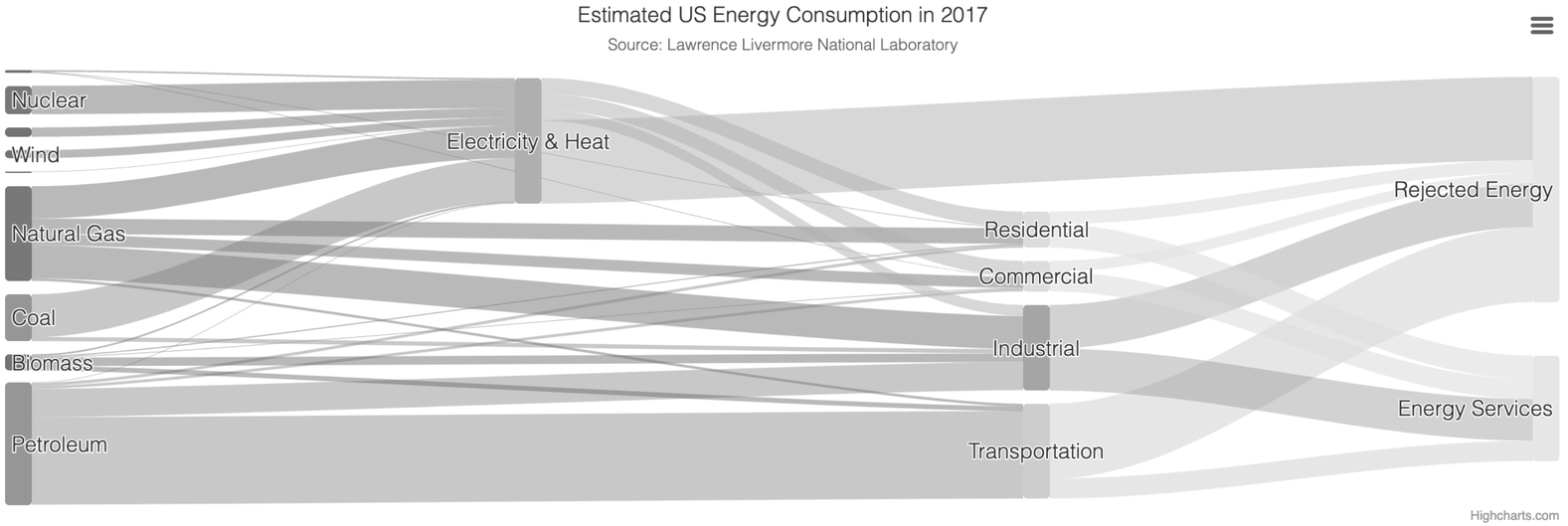
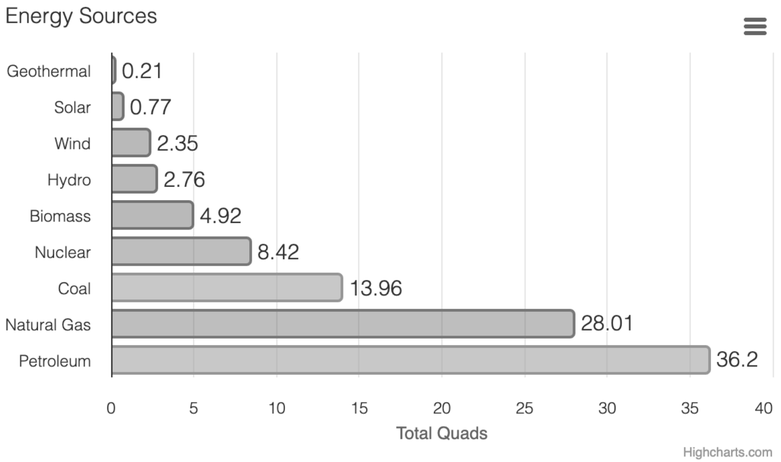
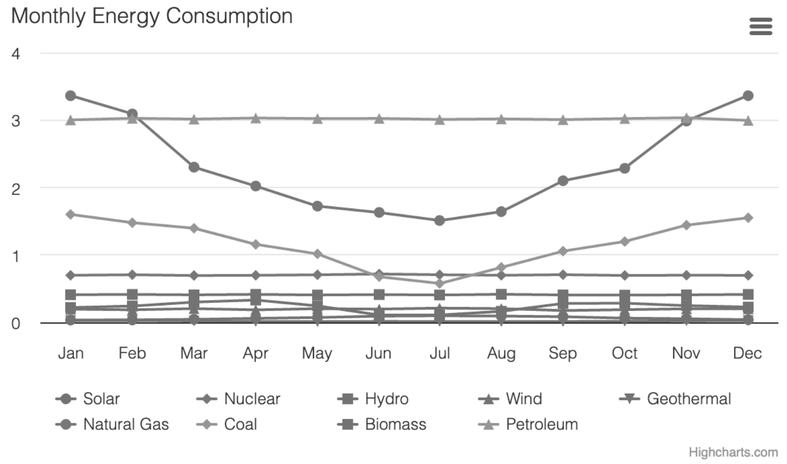
So is the first step just a preferences menu for every chart?



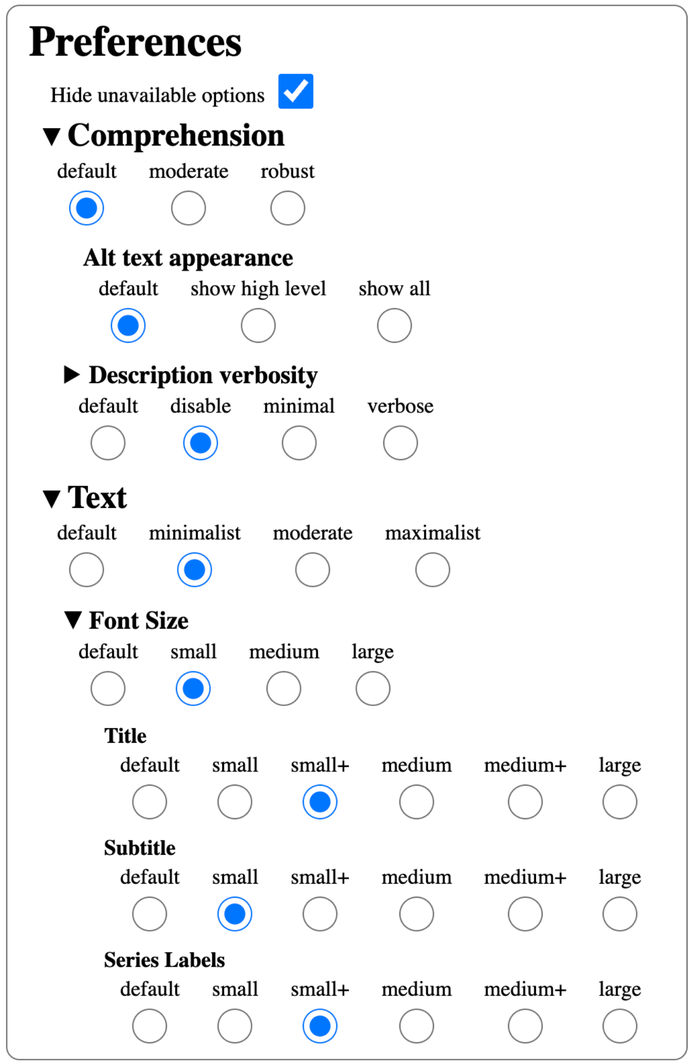


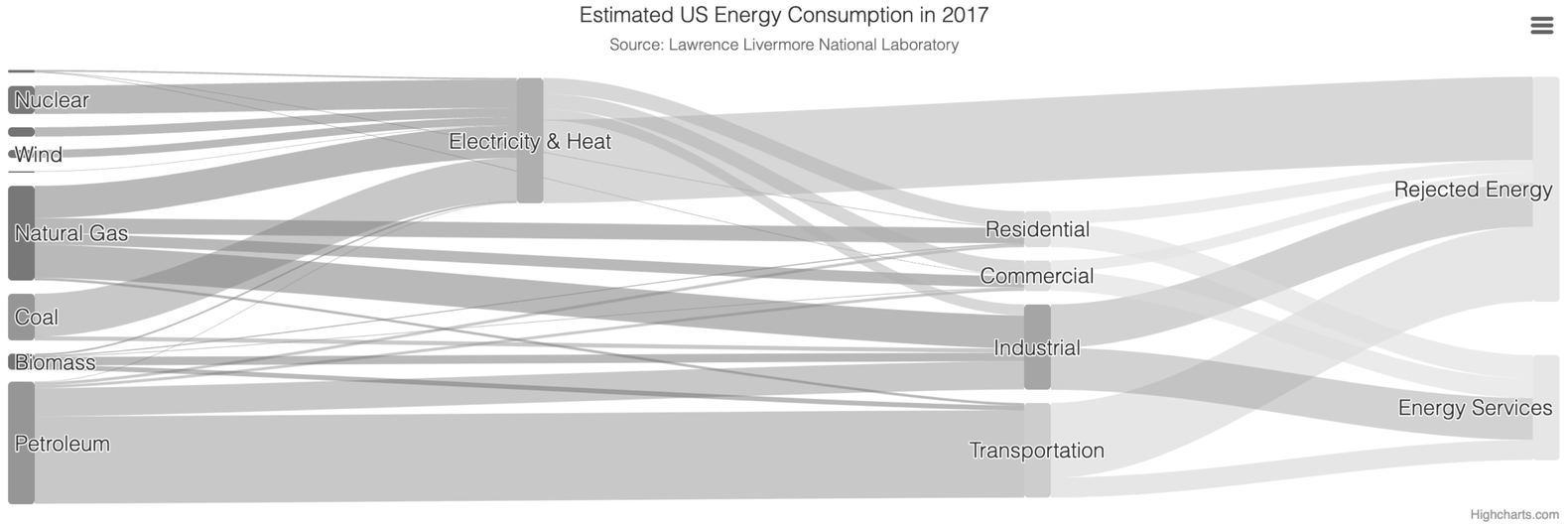


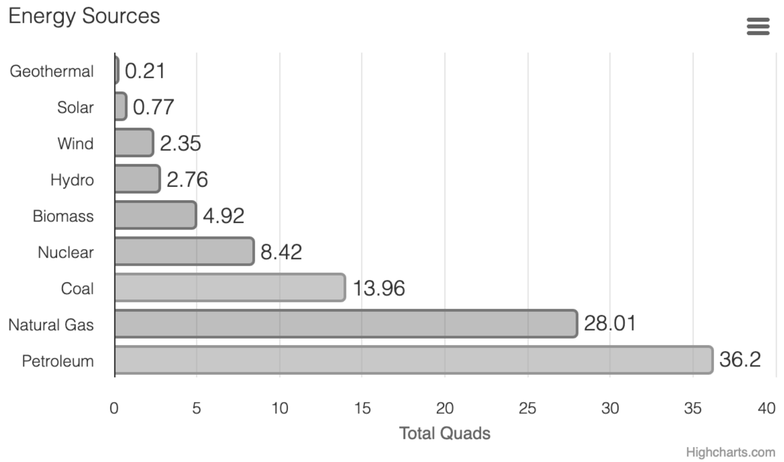


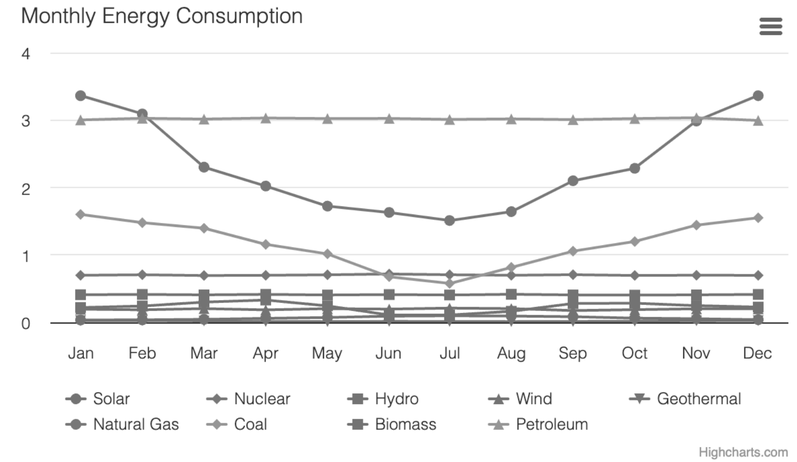
Interactive demo link

So is the first step just a preferences menu for every chart? (no!)



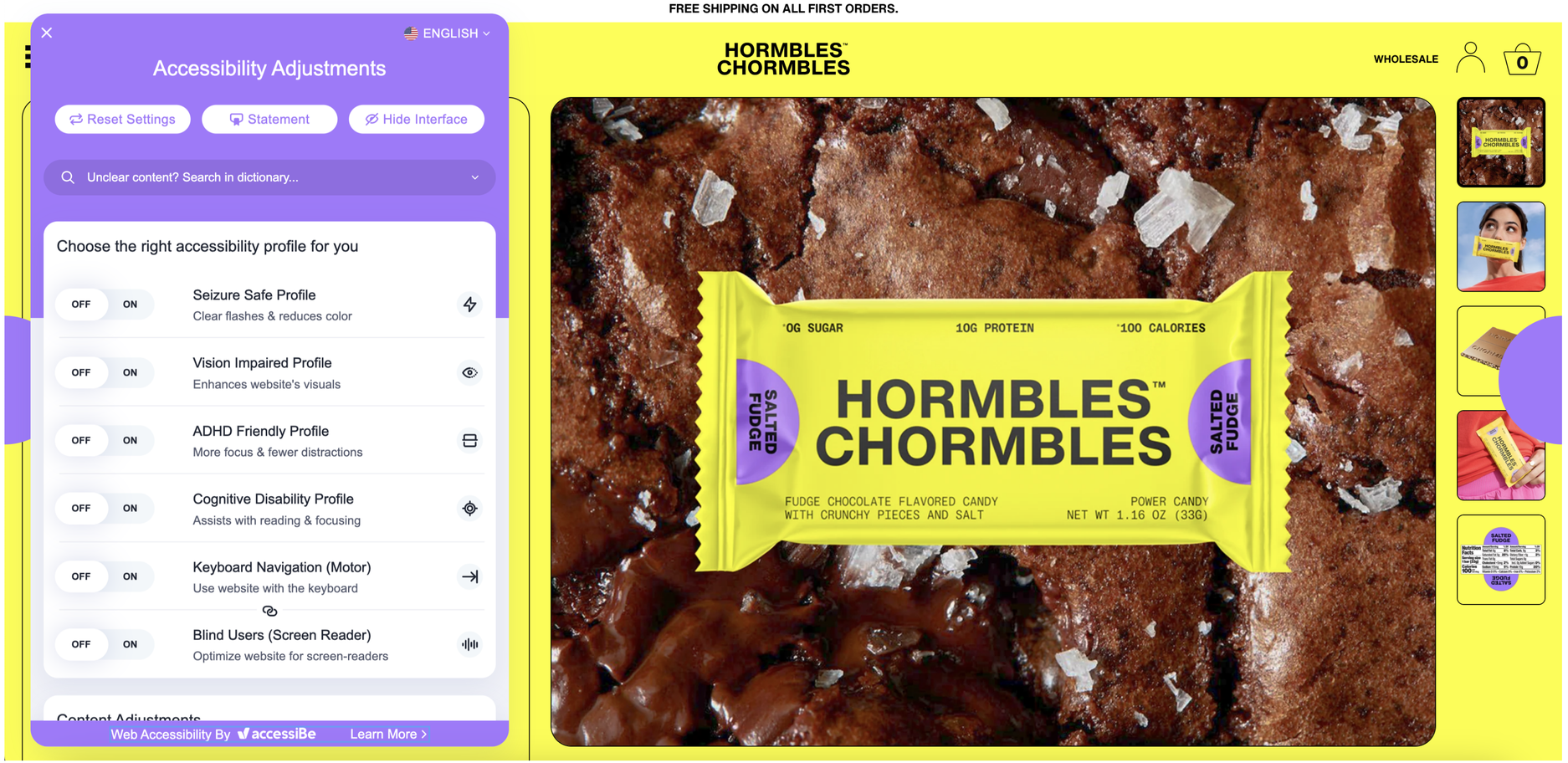




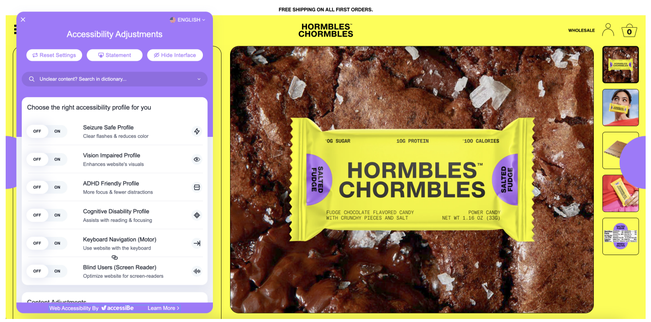


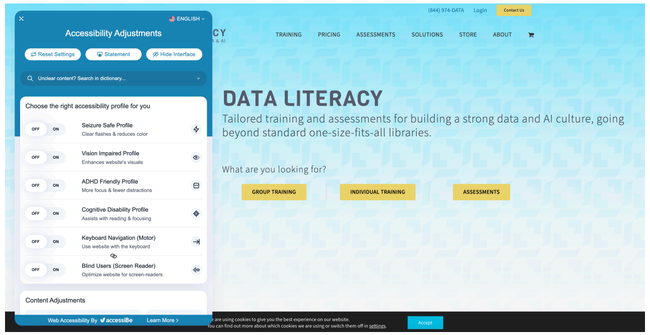
Interactive demo link

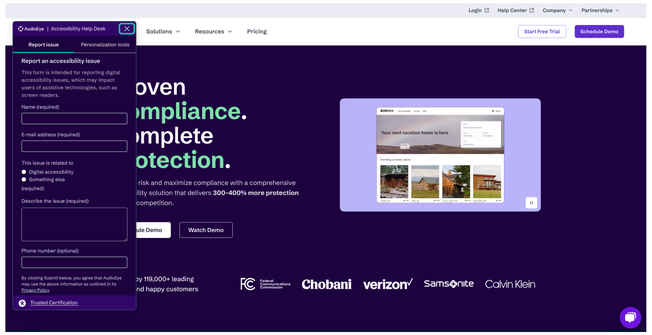
The nightmare of modern “web overlays”

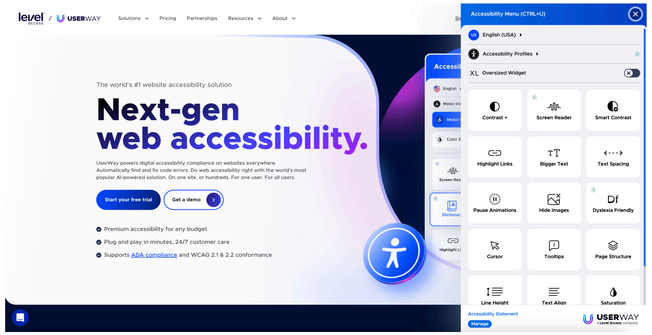


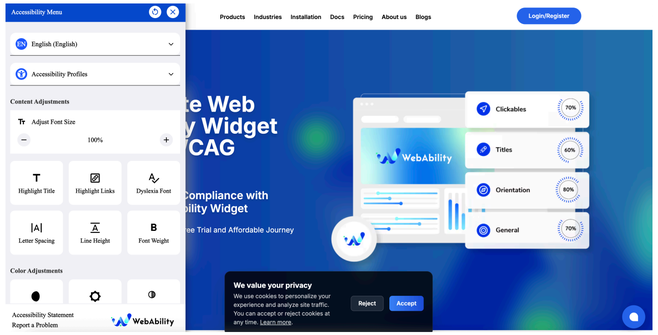
Imagine a world where users actually want this, but for every chart (this world will never exist)

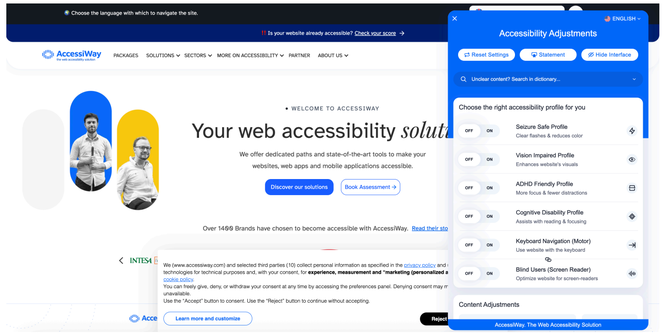




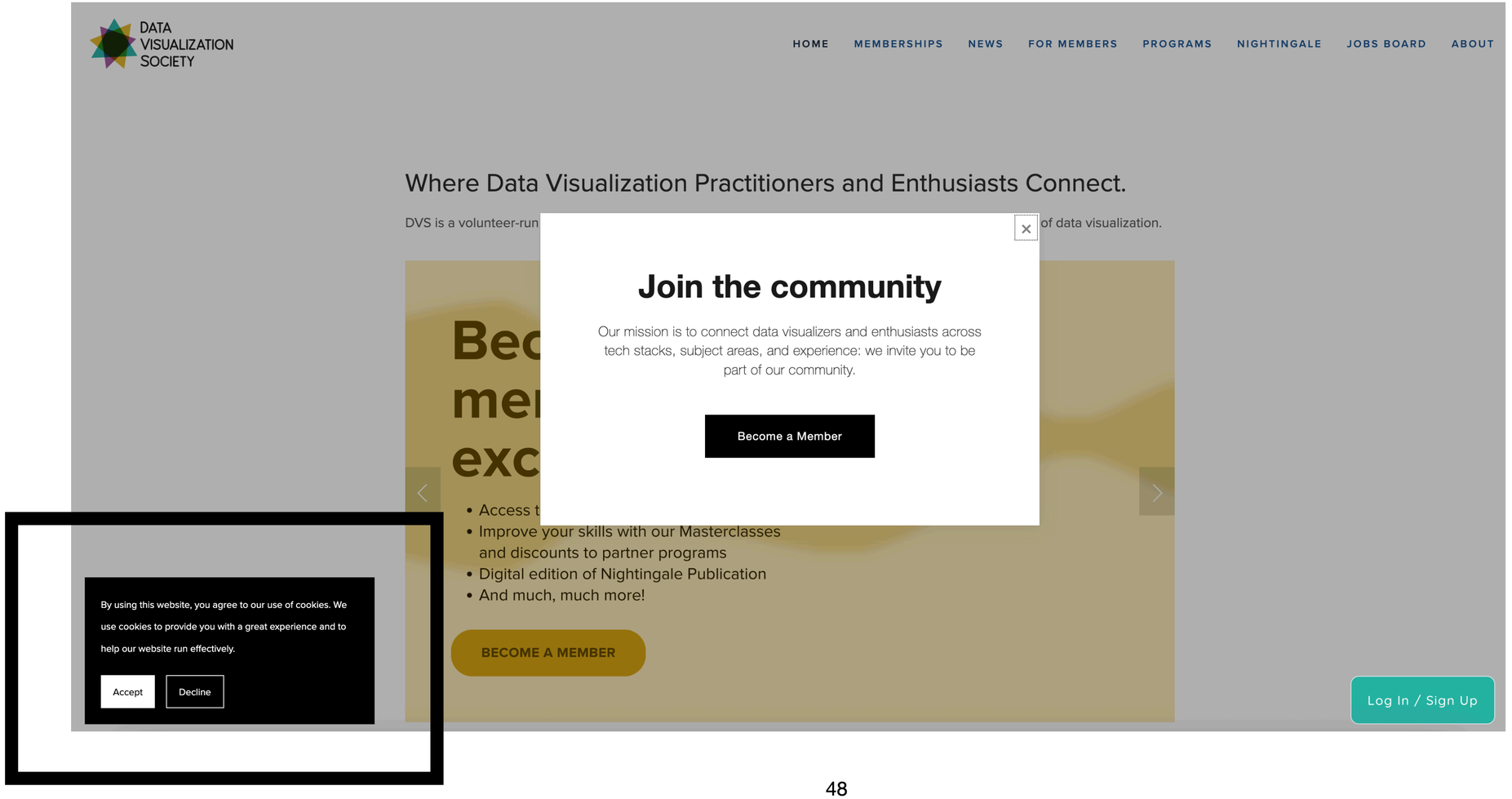








Isn’t it painful that I have to set my cookie preferences on every website ever?



My grand vision of *softerware*:

1. We must make our visualizations accessible

Chartability is a project to help you evaluate accessibility barriers

How do you use Chartability?

There are a lot of different ways to perform an audit, and so there are also many different ways to use Chartability. Sometimes an audit is as casual as checking your work while you do it. And other times it is a big affair that involves teams of specialists and lawyers.

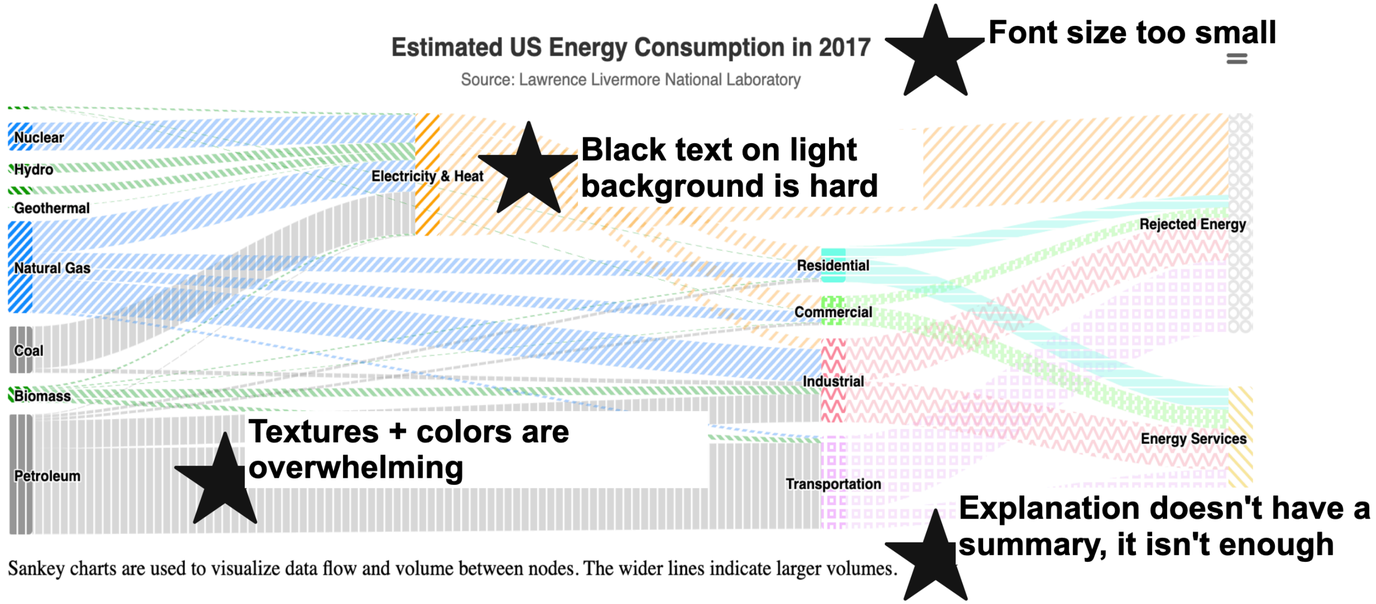
Realistically, while a highly trained auditor may be able to casually evaluate an artifact in as little as 30 minutes or even hold heuristics in mind as they are doing their own creative work, those new to auditing may take anywhere between 2 and 8 hours to complete a full pass of Chartability. Professional audits, which can take weeks or months, often include multiple auditors and provide rigorous documentation and detailed recommendations for remediation, typically in the form of a report. Chartability is meant to serve both quick pass and deep dive styles of audits, so users are expected to leverage it as they see fit.

Below we give an example of what might be a fast pass audit, using Chartability, in 5 steps. This isn't super thorough, but a good way to quickly check a handful of access barriers quickly.

1. Visual Testing

Figure 1: A low contrast chart (left) compared to a higher contrast version (right). A dropper tool is extracting the fill color of the bar and then a contrast ratio has been calculated. Note that the fill color is the same on both bars, but darker borders have been added to ensure the visualization passes contrast tests.

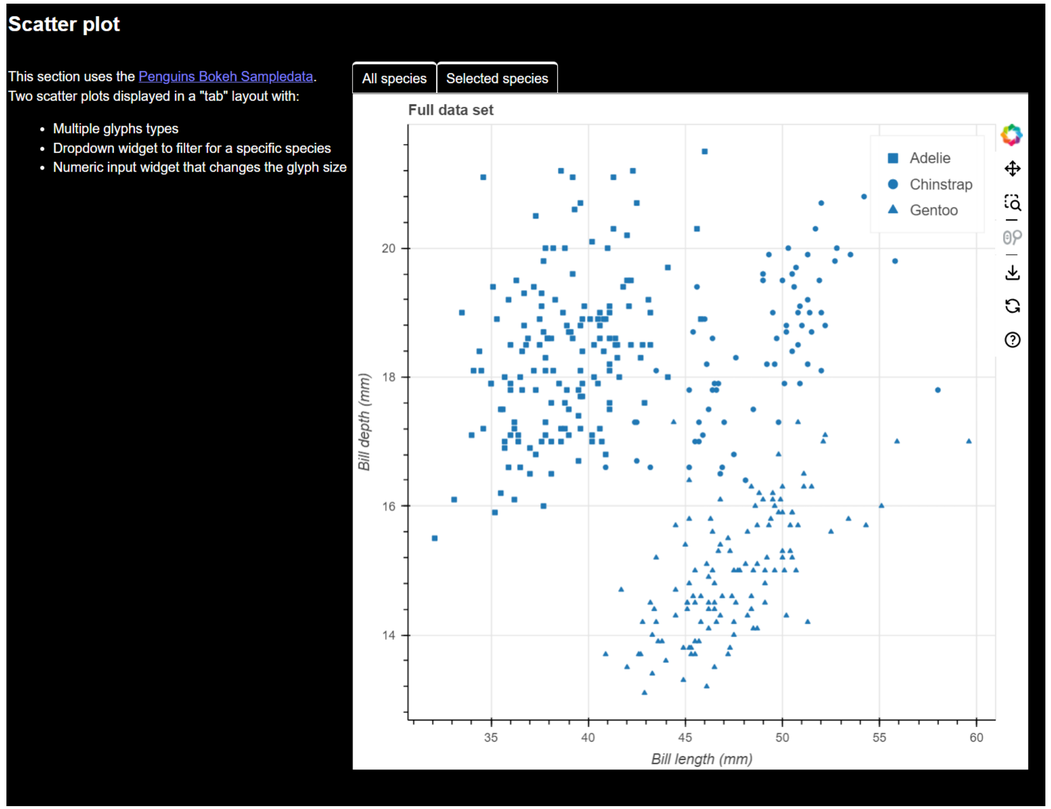
Checking for contrast is the most common critical failure across all of our audits (88% of audits failed this heuristic). In order to evaluate contrast, often a combination of automatic (code-driven) and manual tooling is performed. When manually auditing, practitioners typically use a dropper and a contrast calculator (Figure 1). Contrast is measured by finding adjacent colors that are intended to convey meaning or boundaries, and finding a ratio between them. Standards require a different minimum contrast for text (4.5:1) than geometries like marks in a chart (3:1). Most auditors find this to be one of the easiest tasks to perform, but techniques can be tricky to handle. Testing for contrast accomplishes 3 different heuristics in Chartability, ensuring text/geometries have contrast, interactive states for elements have enough contrast change, and the keyboard focus indicator is easy to distinguish.



Sankey charts are used to visualize data flow and volume between nodes. The wider lines indicate larger volumes.

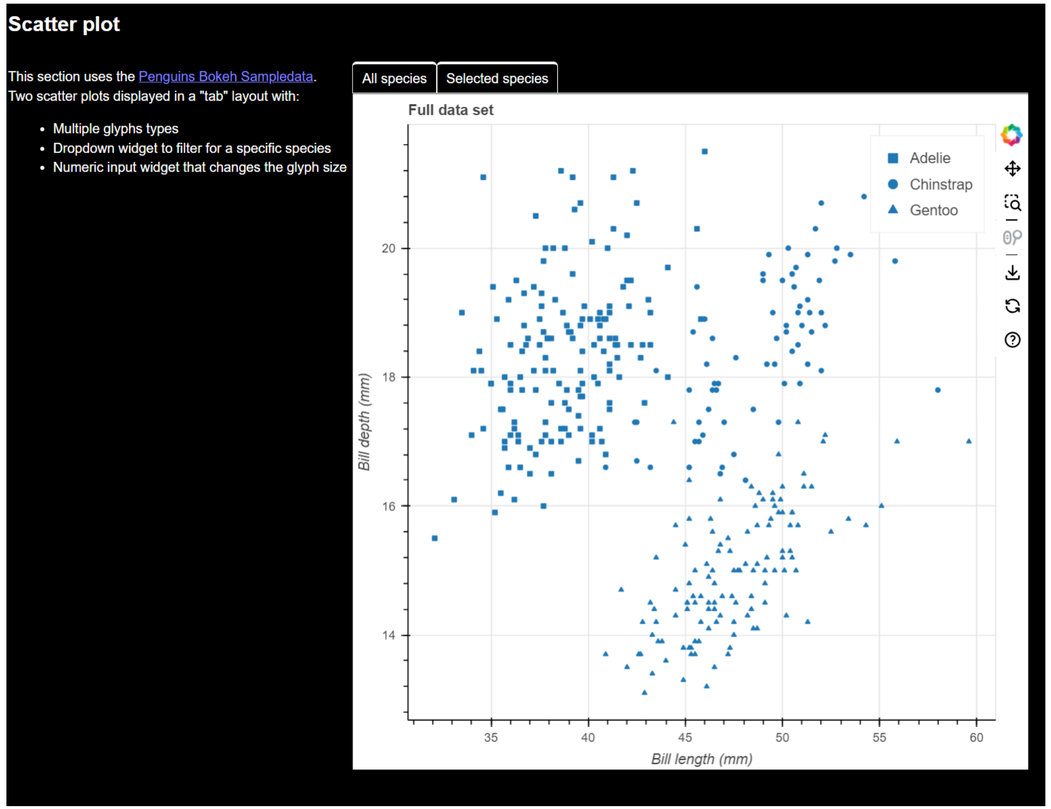
2. Once we do our best, we must respect everyone’s right to repair

What looks wrong about this chart?



Link to our audit of Bokeh

What looks wrong about this chart?



This chart has a white background on a black website - what gives?

Link to our audit of Bokeh

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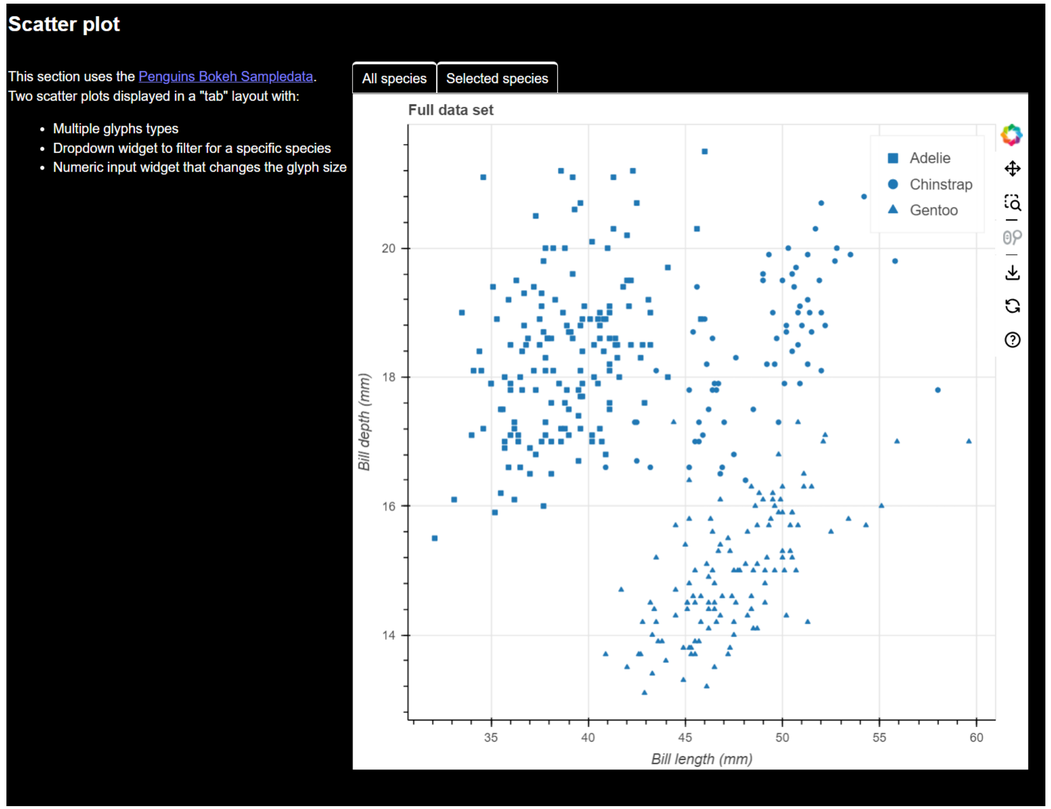
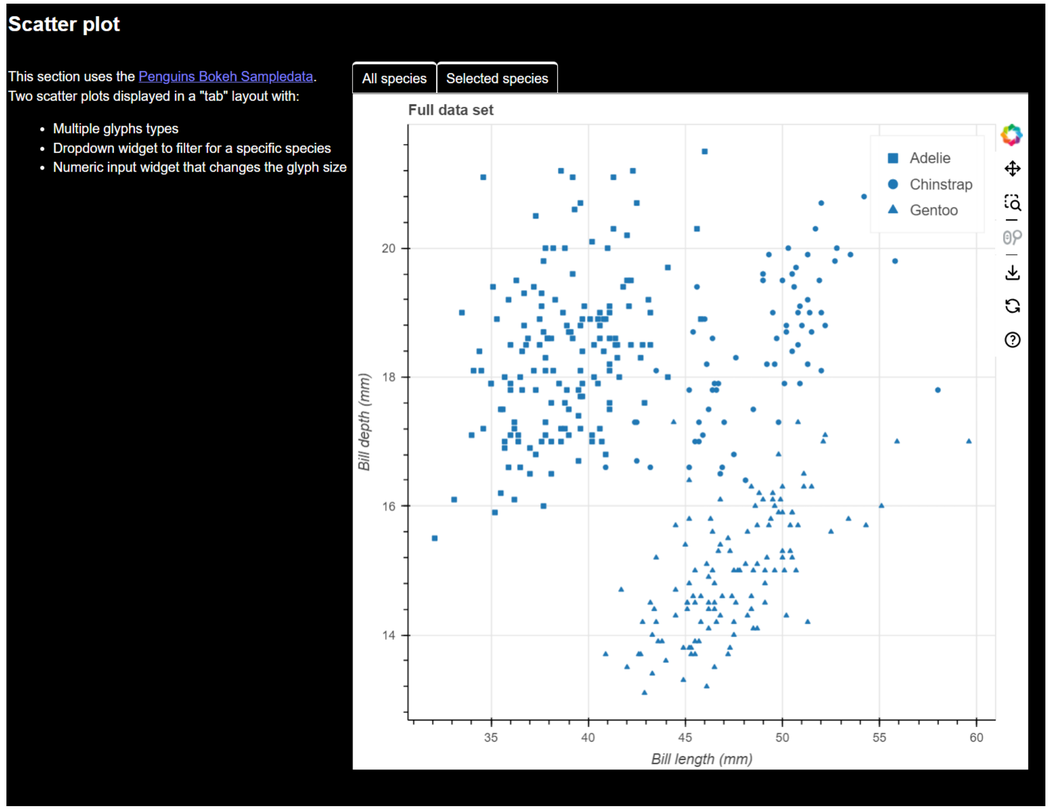


Link to our audit of Bokeh

This chart is a “hard-baked” .PNG, so it can’t adjust to system settings!

Some *softerware* already exists! Our tools need to pay attention to system settings:



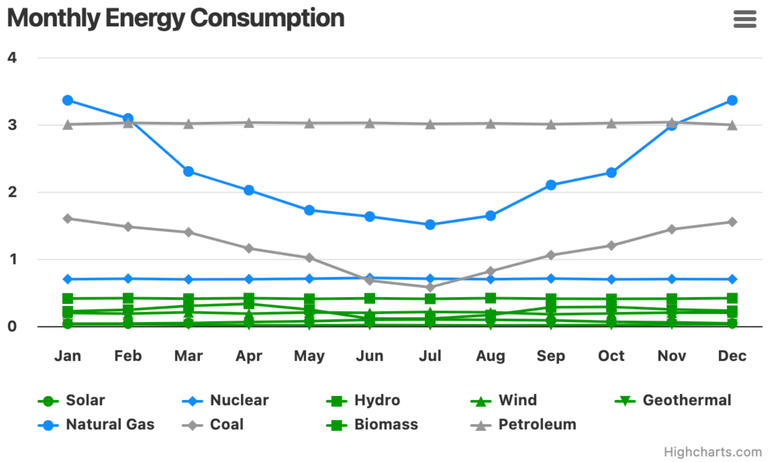
Link to our audit of Bokeh

1. Contrast
2. Redundant encoding
3. Font size
4. Motion reduction

3. We must ensure our visualizations are safe and useful

If we give power to end users, they can create bad visualizations without even knowing!

Original



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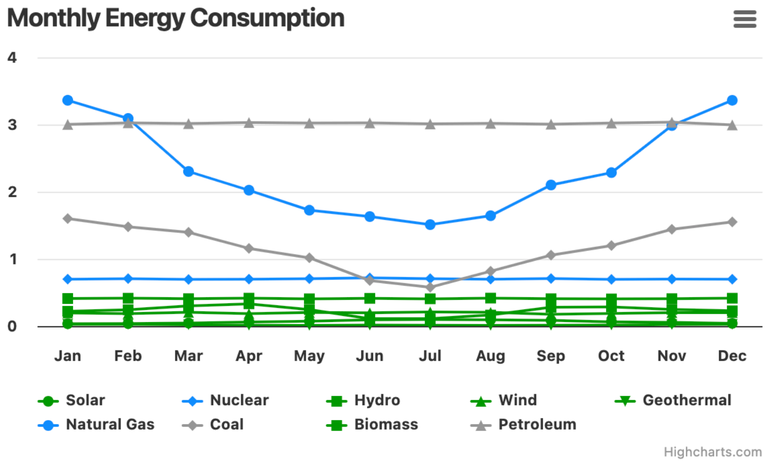
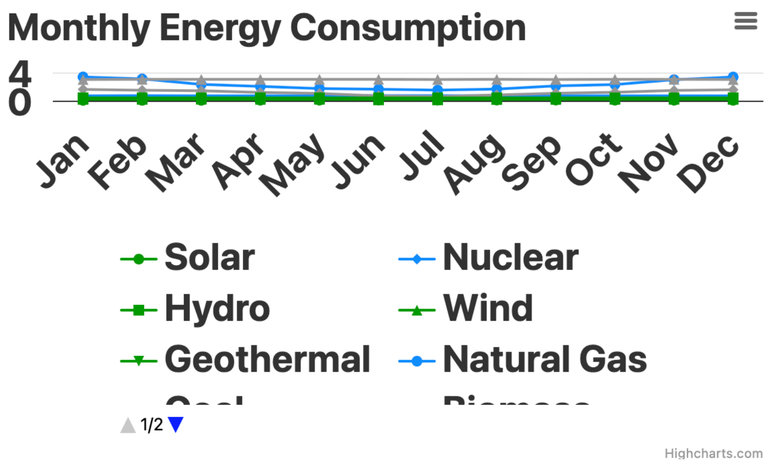
Original

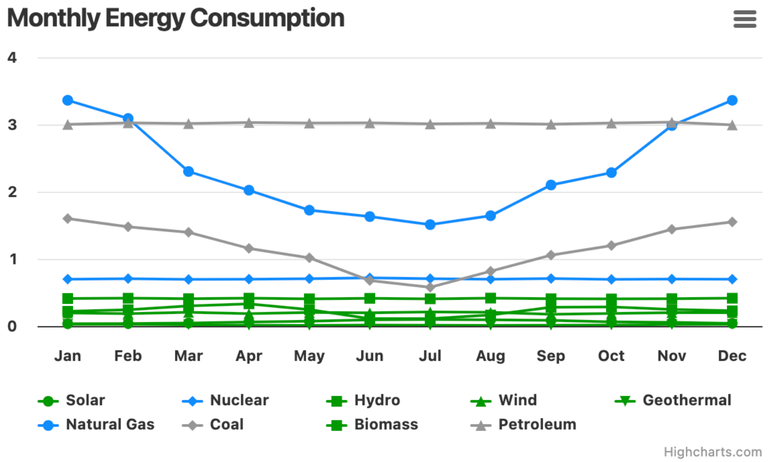


Font size set to very large

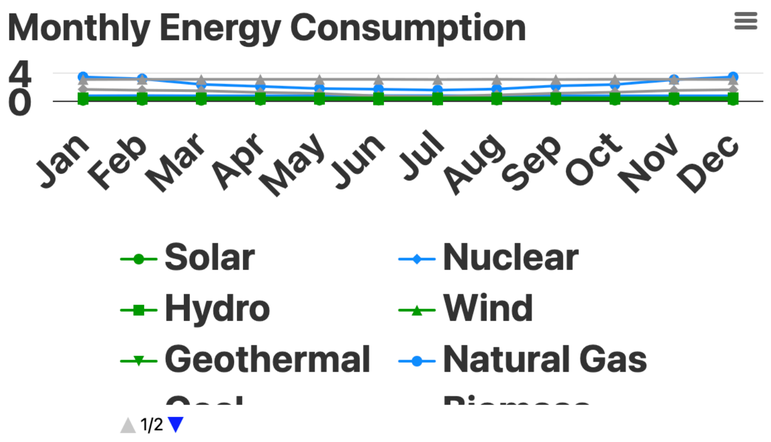


If we give power to end users without being thoughtful, they might create biased or useless visualizations

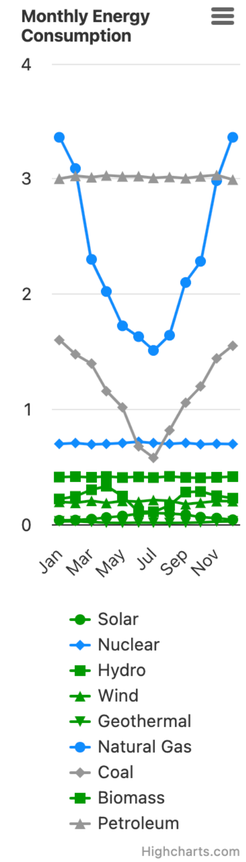
Original



Font size set to very large

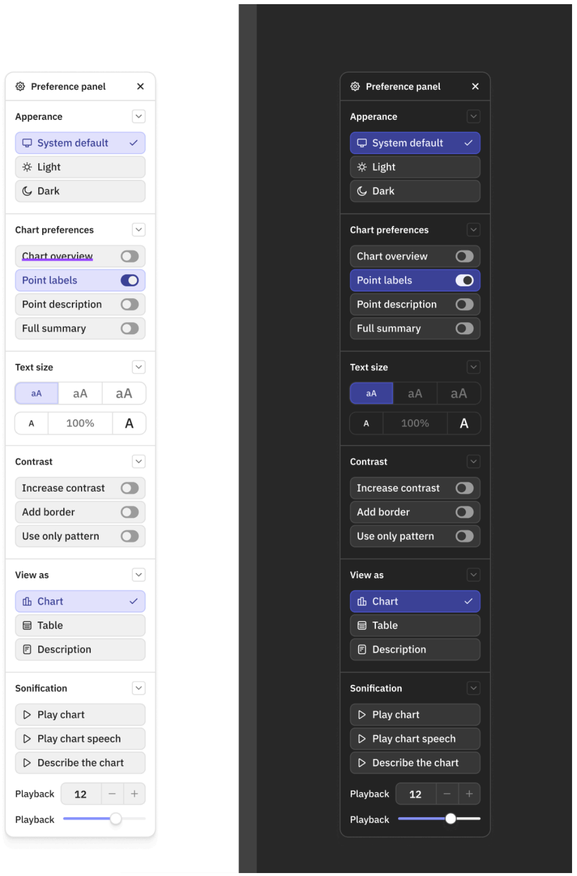


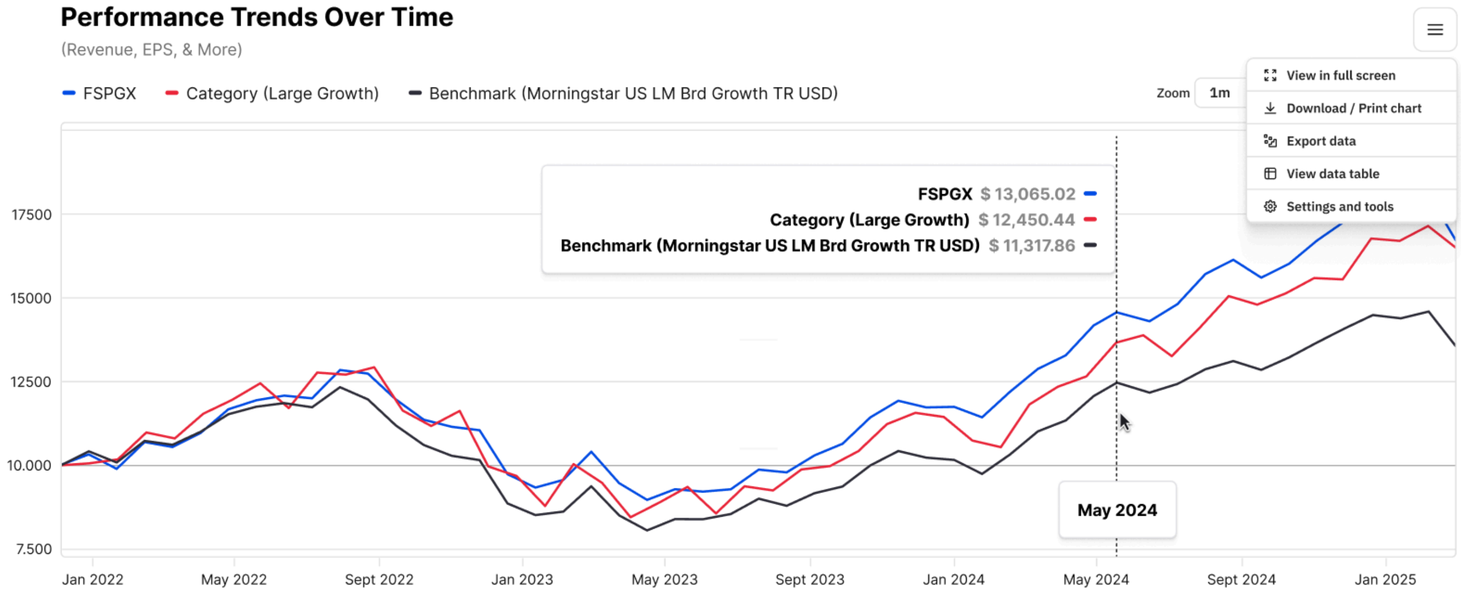
Aspect ratio made tall



4. Our visualizations should support *interdependence*

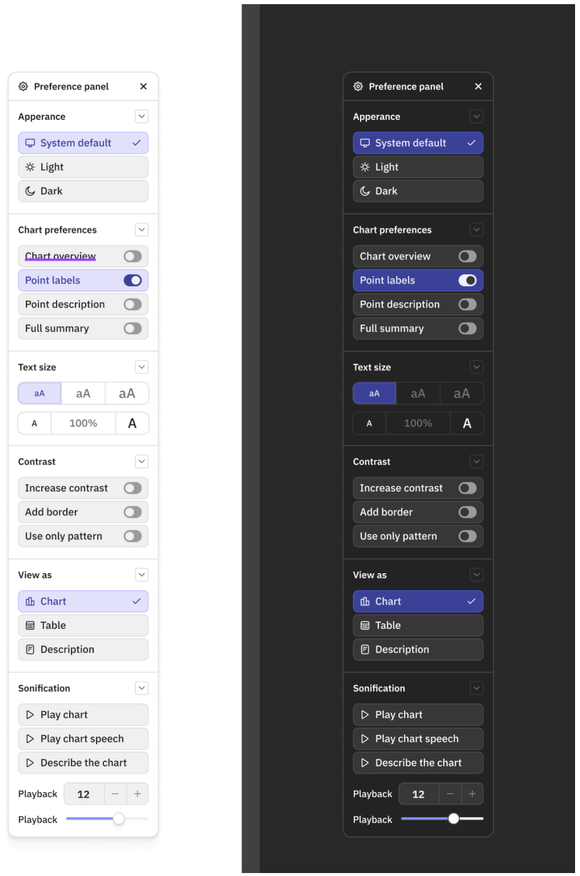
We need infrastructures that are interoperable!

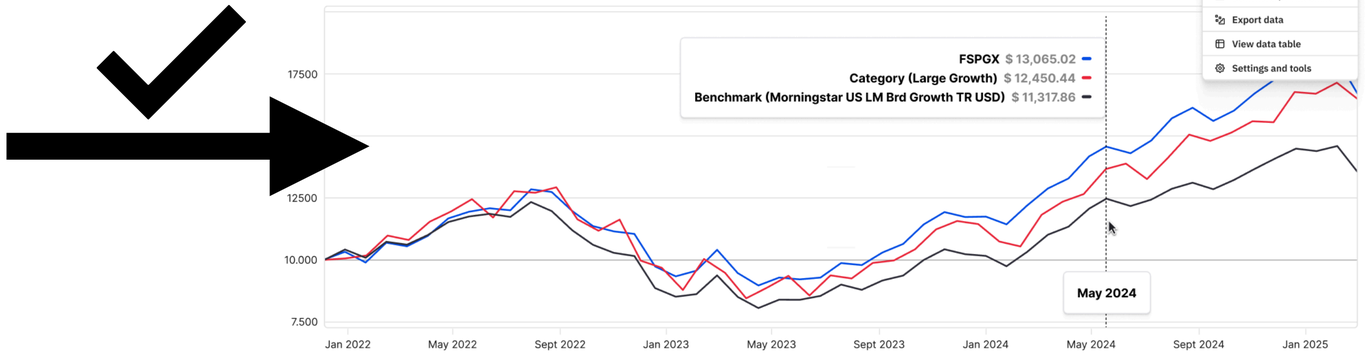




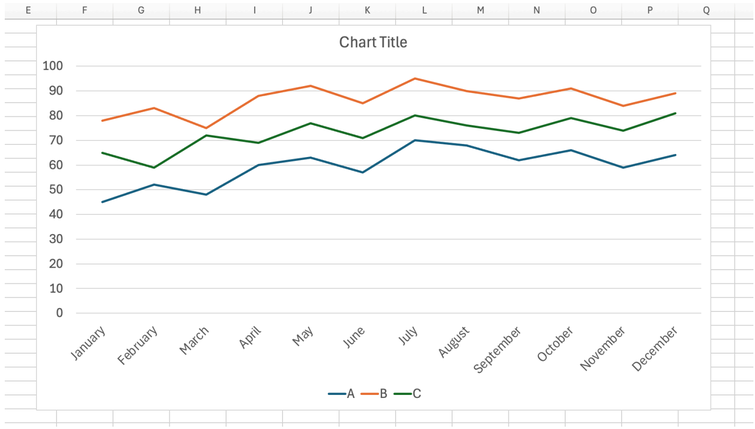
Credit: Marita Vindedal, Highcharts' Design R&D

Participants asked: “can I get these Highcharts settings in Excel? Tableau? My google analytics dashboards?”





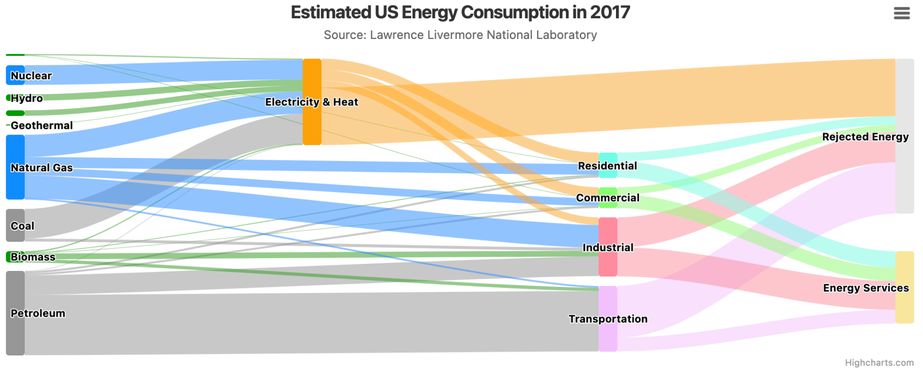
(Highcharts)



(Microsoft Excel)

Credit: Marita Vindedal, Highcharts’ Design R&D

Not everyone is comfortable with or wants to perform the labor of personalizing, building, or repairing!



Sankey charts are used to visualize data flow and volume between nodes. The wider lines indicate larger volumes.

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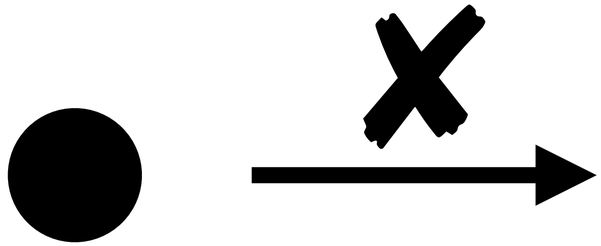
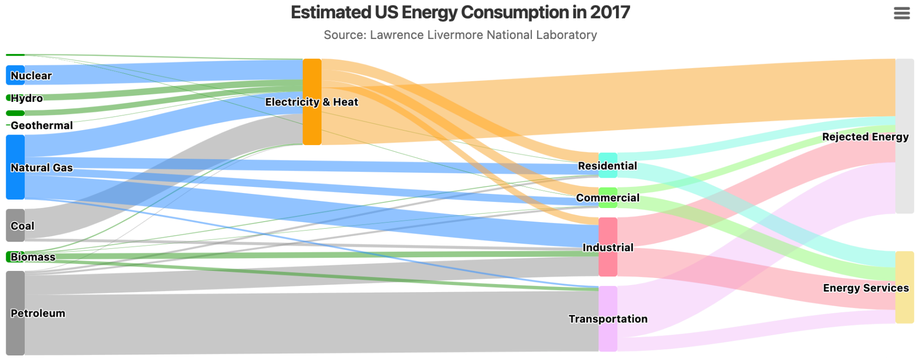


This low-vision user has a hard time,
but doesn't understand all the settings



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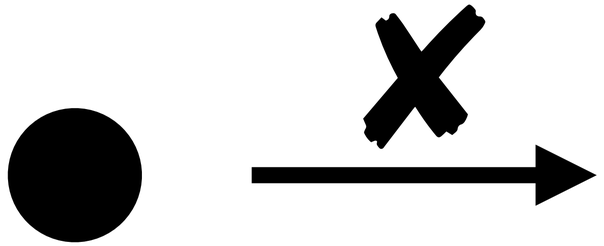
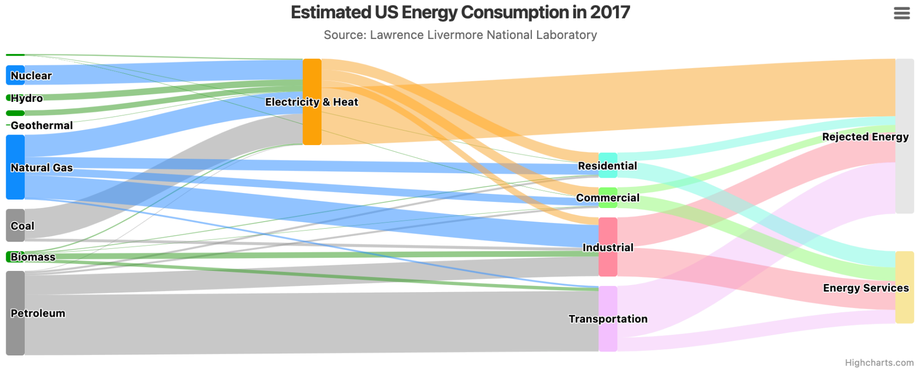
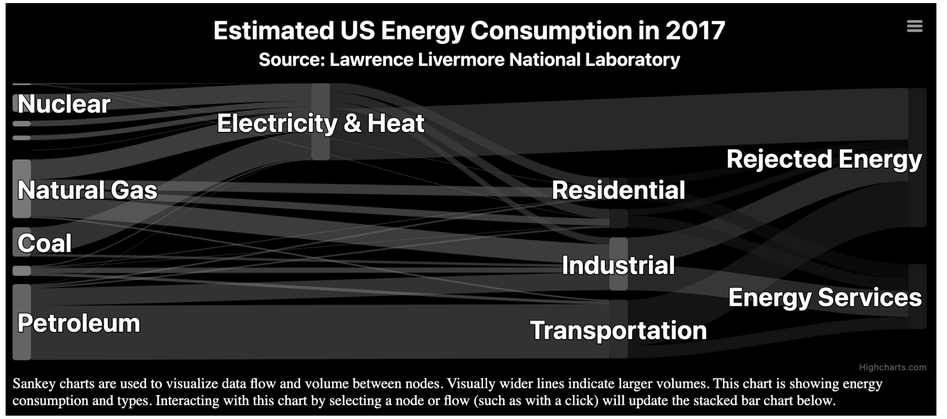




Sankey charts are used to visualize data flow and volume between nodes. The wider lines indicate larger volumes.

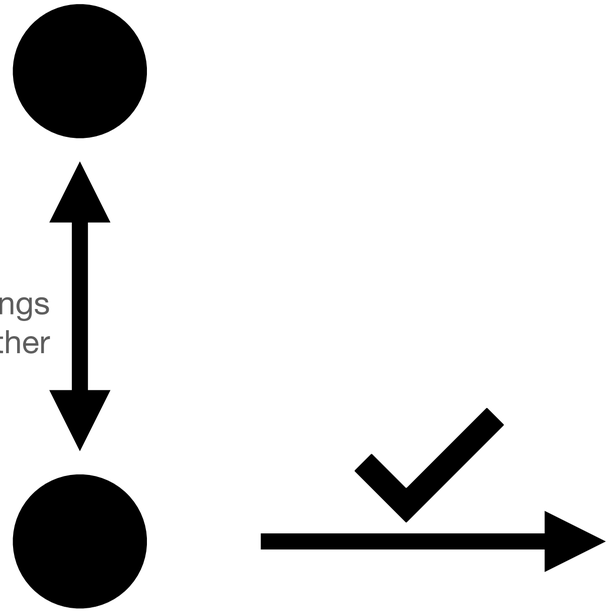
But this power user who is also low-vision loves to customize!

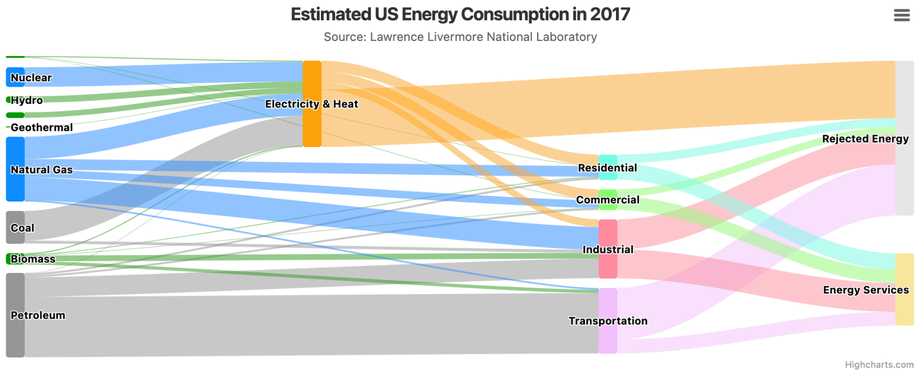


Sankey charts are used to visualize data flow and volume between nodes. Visually wider lines indicate larger volumes. This chart is showing energy consumption and types. Interacting with this chart by selecting a node or flow (such as with a click) will update the stacked bar chart below.

Interdependence is providing a way for people to help each other

These users could share settings with each other





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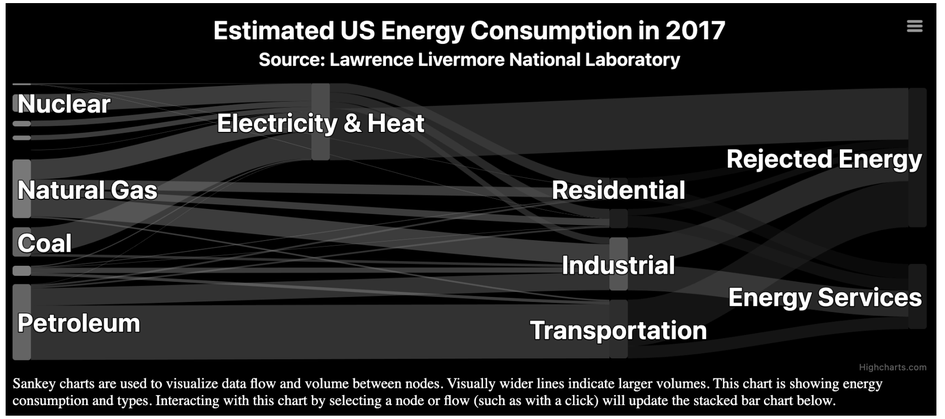

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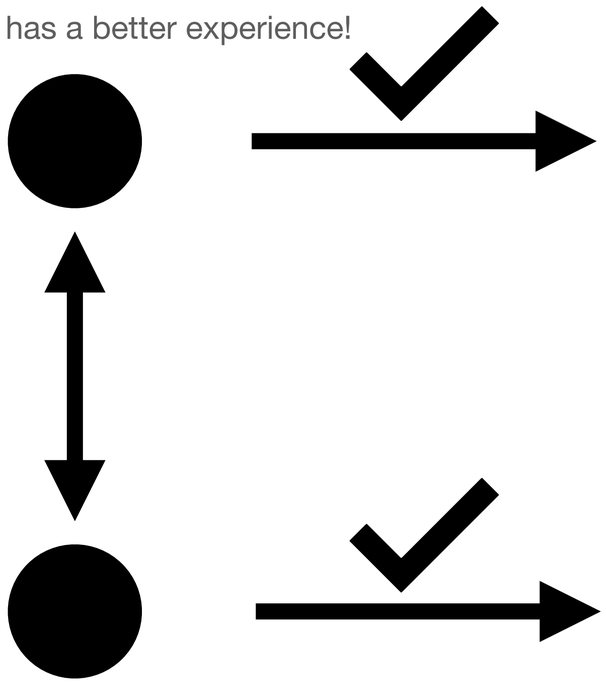
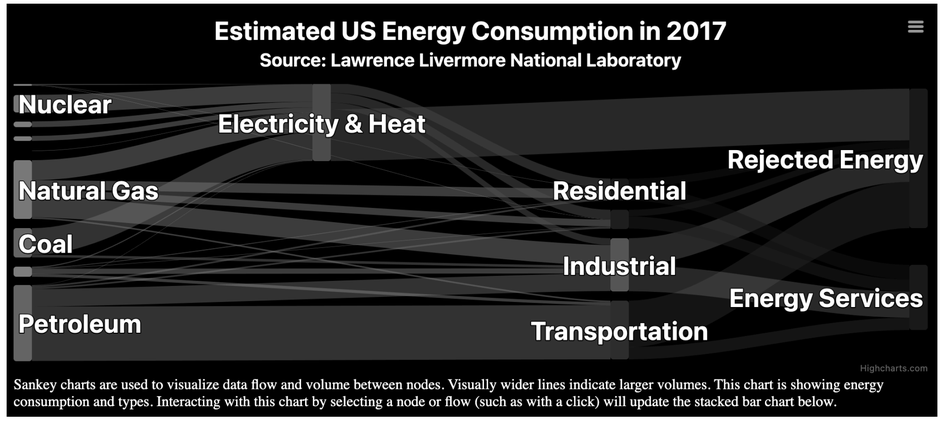
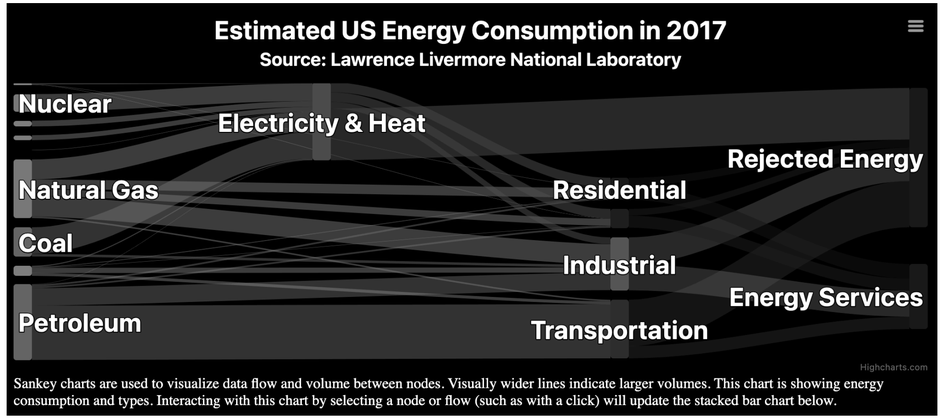
Interdependence is providing a way for people to help each other

Now this user has a better experience!







My grand vision of *softerware*:

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1. Provides basic access

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4. Supports interdependence

A final provocation:

Language models won’t save us from bad design.

2025

frank.computer

Softerware:
My grand challenge to my peers

Re-imagining data visualizations as malleable interfaces

Frank Elavsky

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