

Lawrence Livermore National Laboratory

Energy Informatics: Support for Decision Makers through Energy, Carbon and Water Analysis

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Project ID #
AN014

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May 10, 2011

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This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344

Overview

- **Project Start:** **October, 2007**
- **Project End:** **Ongoing**
- **Percent Complete:** **50%¹**

Timeline

- **Systems Analysis Barrier A:**
 - Future Market Behavior
- **Systems Analysis Barrier E:**
 - Unplanned Analyses
- **Production Barrier D:**
 - Feedstock Issues

Barriers

- **Total Funding:** **\$840k + \$200k**
- **FY07 – 10 Funding:** \$640k
- **FY11 Funding:** \$200k (expected)

Budget

- **Past:**
 - NREL, Sandia

Partners



Relevance: Energy and Carbon

By 2010, the most significant climate change policy making in the United States had occurred at state and municipal levels... US climate change politics has been characterized by bottom-up dynamics and policy developments.

Selick and VanDeveer (2011), <http://onlinelibrary.wiley.com/doi/10.1002/wcc.94/full>

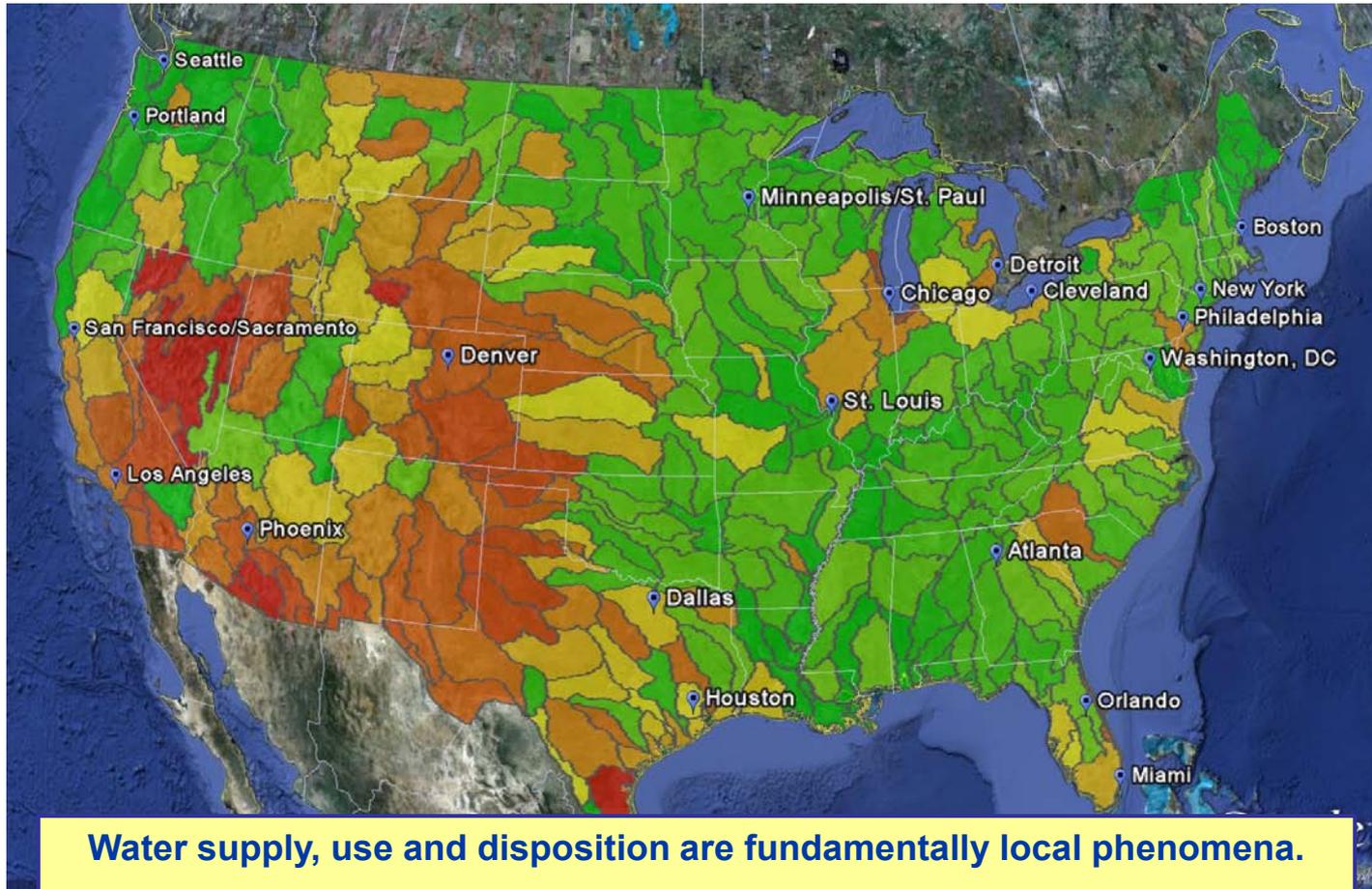
State and local governments also play crucial roles, most especially because of their regulatory responsibilities in support of consumers. For example, local building codes and state utility commissions are among the most important influences on the adoption of many new energy technologies.

President's Council of Advisors on Science and Technology (2010)

<http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-energy-tech-report.pdf>



Relevance: Water



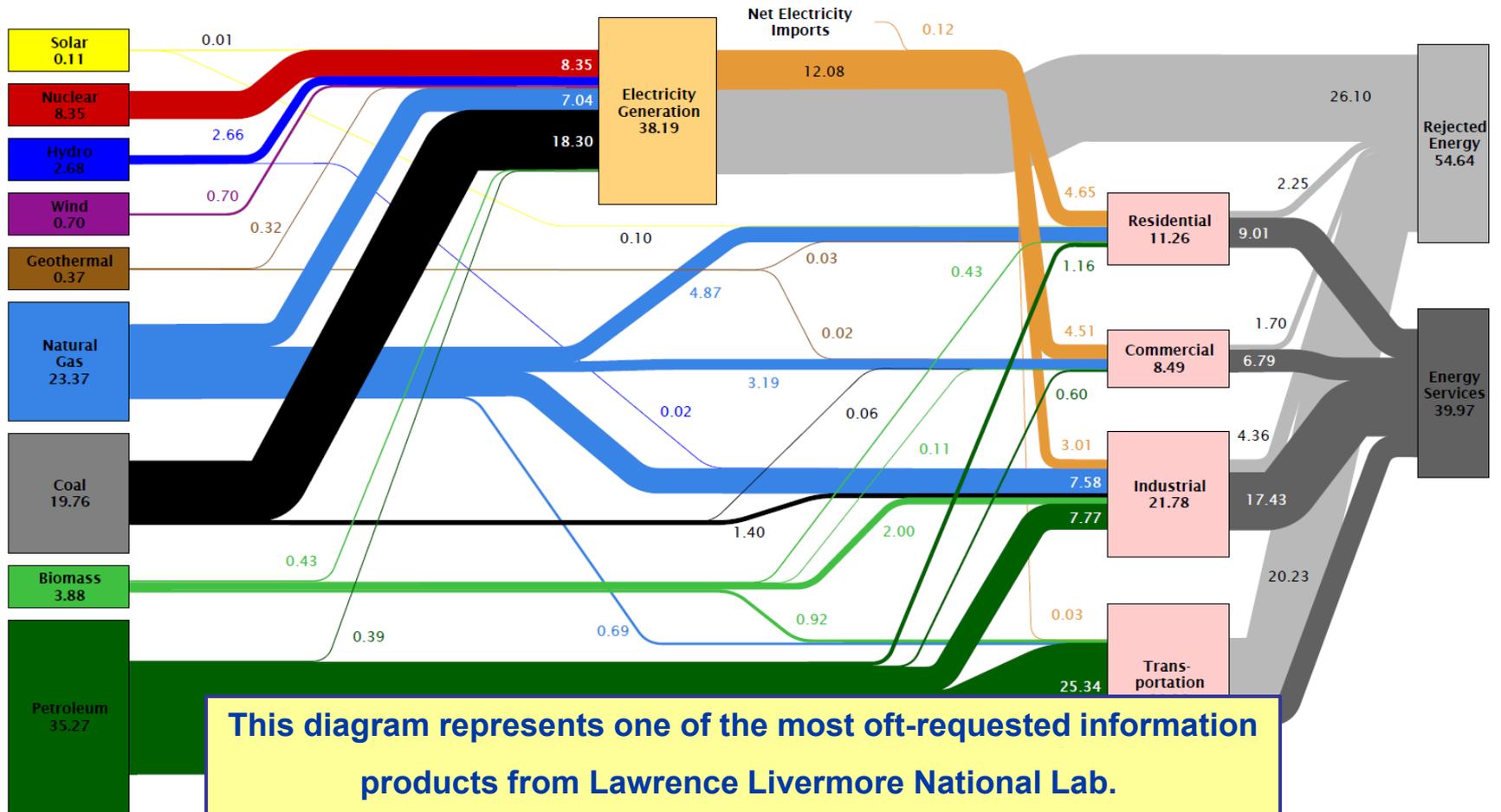
Objectives

- Complement geospatial visualization of energy statistics with a structural depiction of energy systems at multiple scales.
- Aid local, national and international decision-makers with quantitative data tied to qualitative structural information about the state of their energy systems.
- Production Barrier D: Feedstock Issues
 - Energy-Water Nexus
- Systems Analysis Barrier A: Future Market Behavior
 - Local feedstock and environmental issues
- Systems Analysis Barrier E: Unplanned Analyses



Approach: Sankey Diagrams

Estimated U.S. Energy Use in 2009: ~94.6 Quads



This diagram represents one of the most oft-requested information products from Lawrence Livermore National Lab. A structural view of energy systems is being used throughout DOE.

Approach: Data Management

- U.S. Water Flow, State Level Water Flow
 - Source: US Geological Survey Circular 1344 and associated spreadsheet data
 - Analyze county-level data (~300,000 data points) to identify ~40 critical water indicators for each state
- State-level Energy Flow
 - Source: EIA's State Energy Data System (SEDS)
 - Analyze ~30MB data file to identify ~40 critical energy indicators for each state
- State-level Carbon Flow
 - Sources: SEDS, Energy Information Agency (EIA)'s Electricity Annual, EIA's Emissions of Greenhouse Gases
 - "Data Fusion" of State-level energy results with EIA's other data resources



Approach: Data Management

- International Energy Flow
 - Source: International Energy Agency (IEA)'s Extended World Energy Balance
 - Aggregate ~5000 points per country down to ~60 critical energy statistics
- Residential Energy Flow
 - Source: EIA's Residential Energy Consumption Survey (RECS)
 - Methodology TBD (Scenario Analysis in concert w/EEERE)
- Transportation Energy Flow
 - Source: EIA's Annual Energy Outlook, Department of Transportation (DOT)'s Bureau of Transportation Statistics (BTS)
 - Methodology TBD (Scenario Analysis in concert w/EEERE)



Approach: Data Management

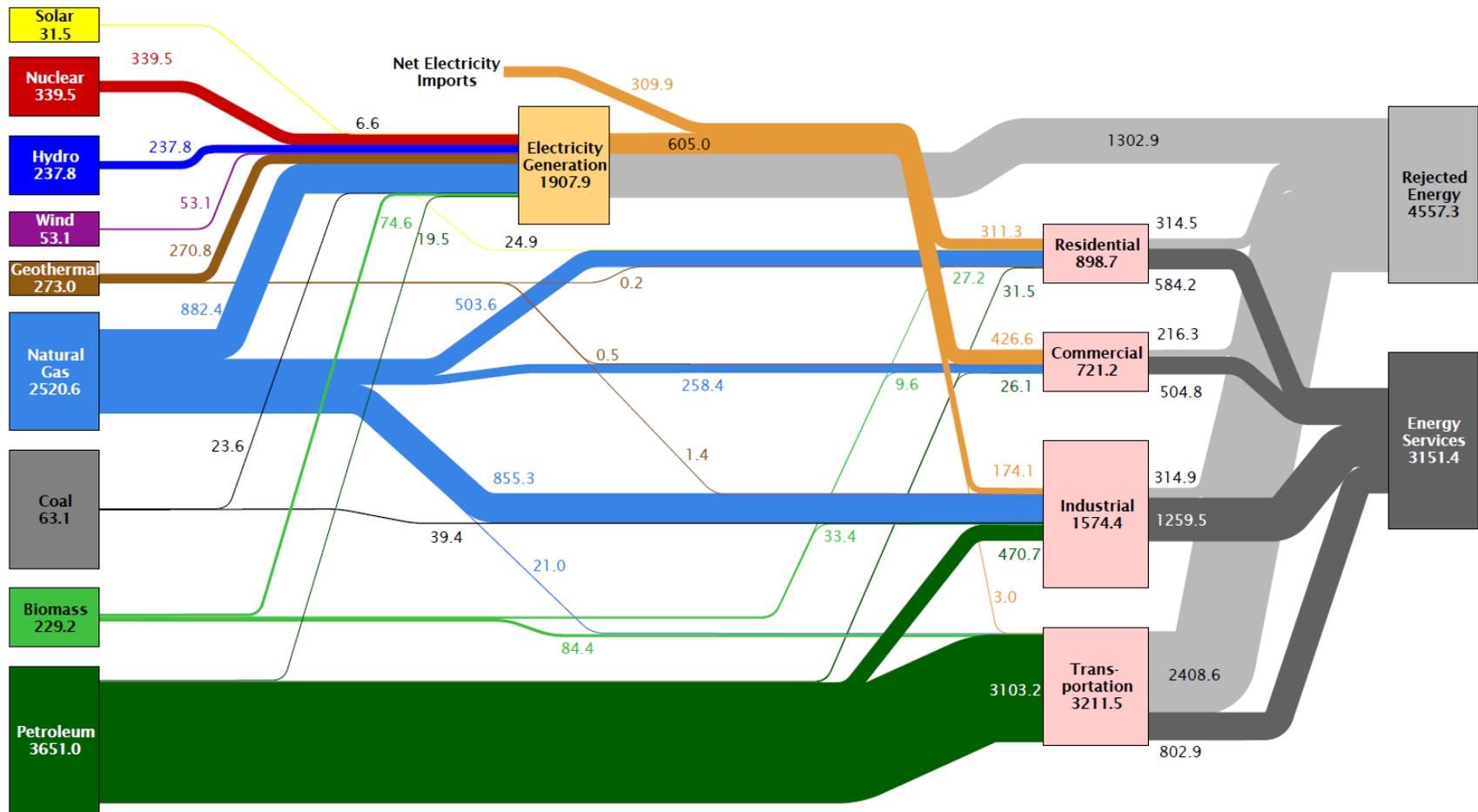
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 - N

The data-to-graphic workflow combines expert human analysis of data with automated chart generation.



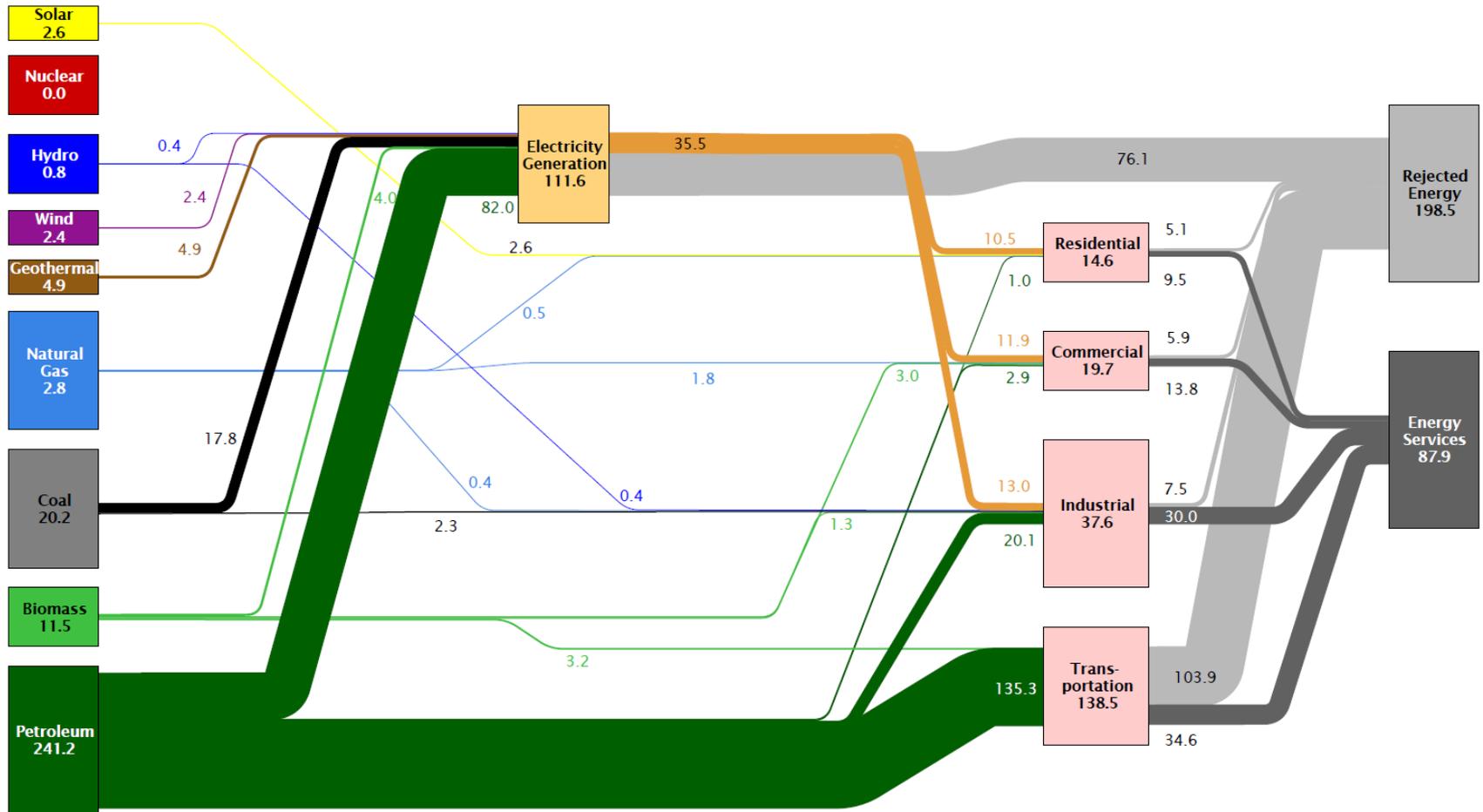
Accomplishments: State-level Energy Flow

Estimated California Energy Use In 2008
~8381.5 Trillion BTU



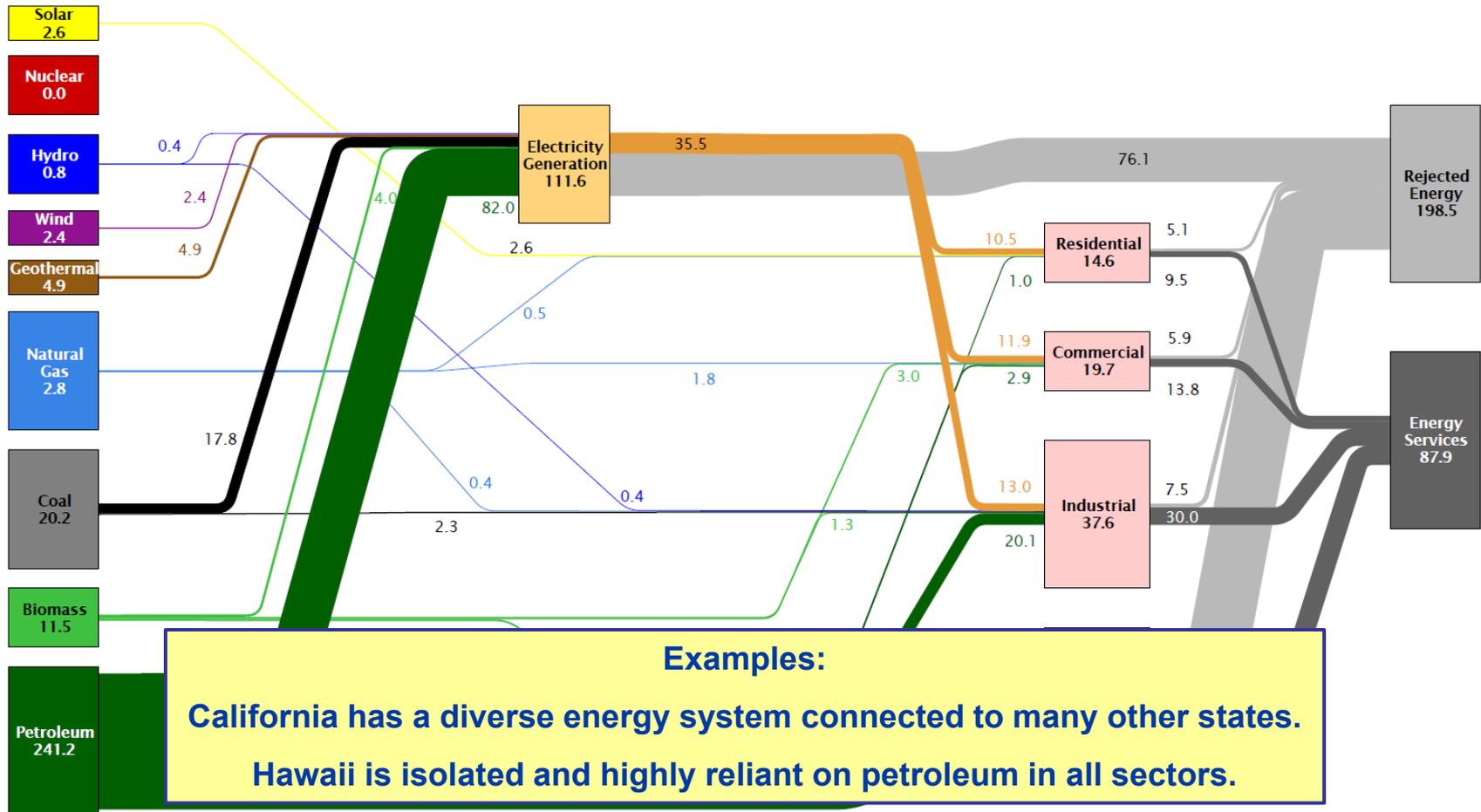
Accomplishments: State-level Energy Flow

Estimated Hawaii Energy Use In 2008
~283.8 Trillion BTU



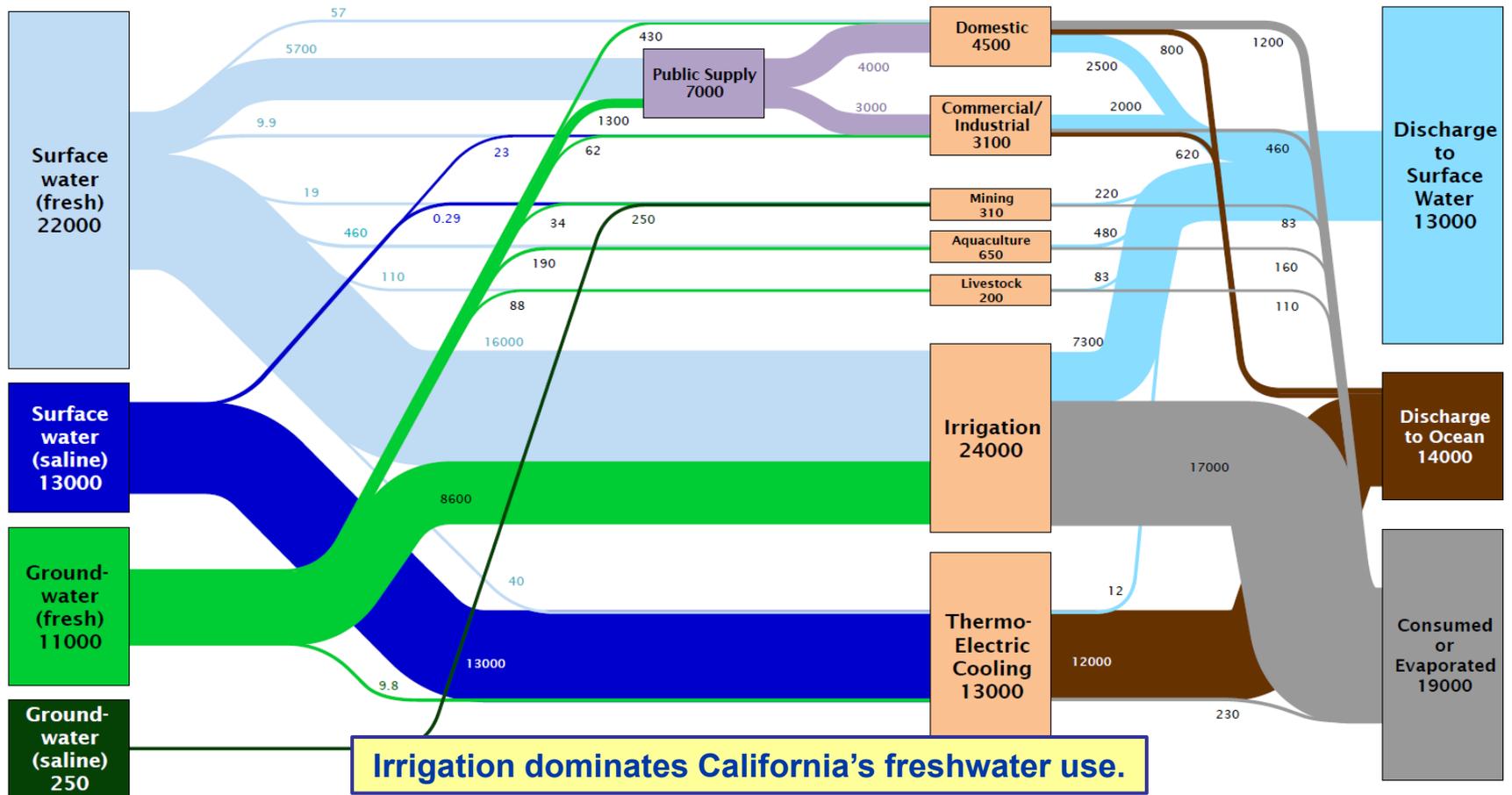
Accomplishments: State-level Energy Flow

Estimated Hawaii Energy Use In 2008
~283.8 Trillion BTU



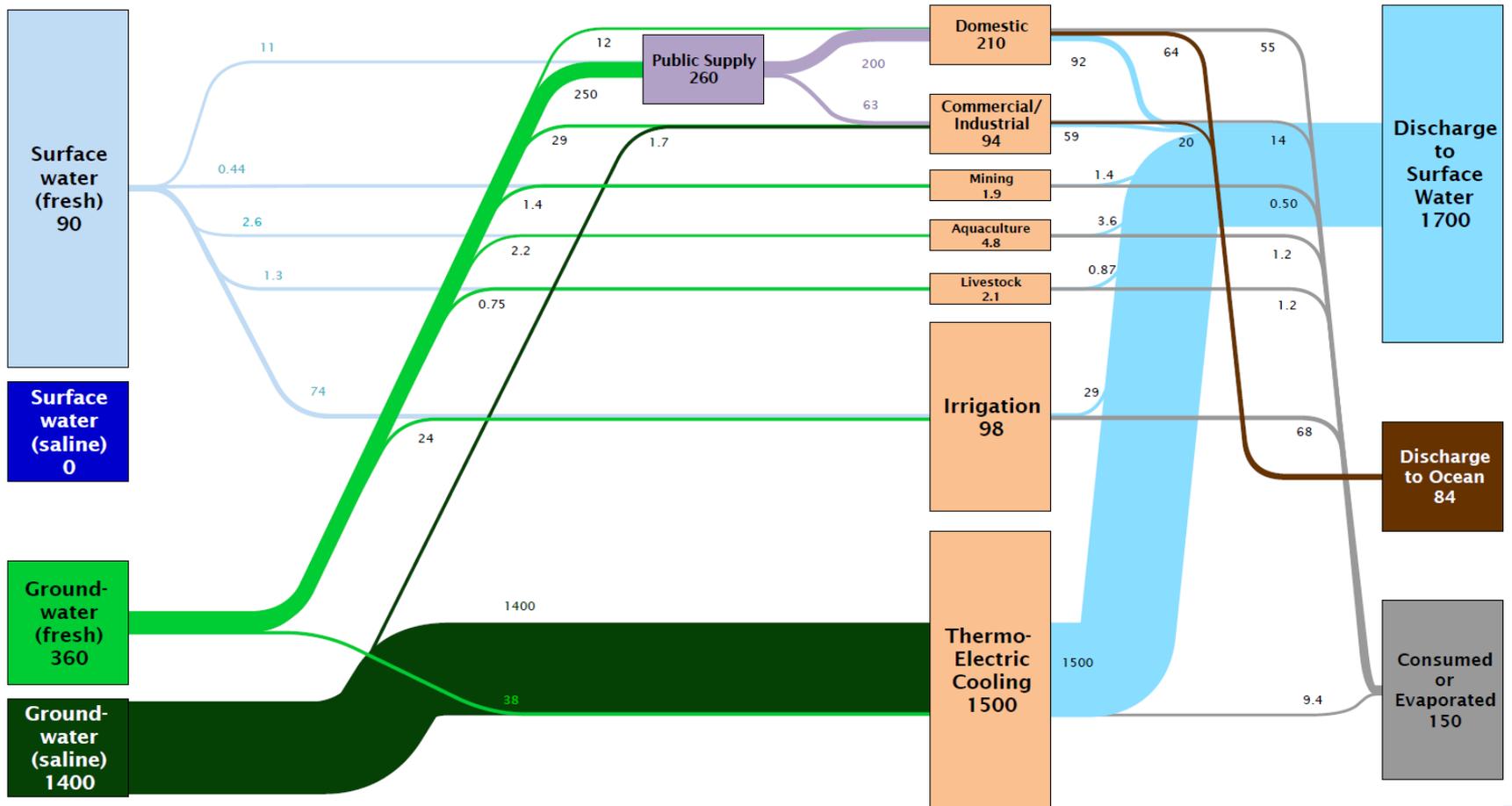
Accomplishments: State-level Water Flow

Estimated California Water Flow in 2005:
46000 Million Gallons/Day



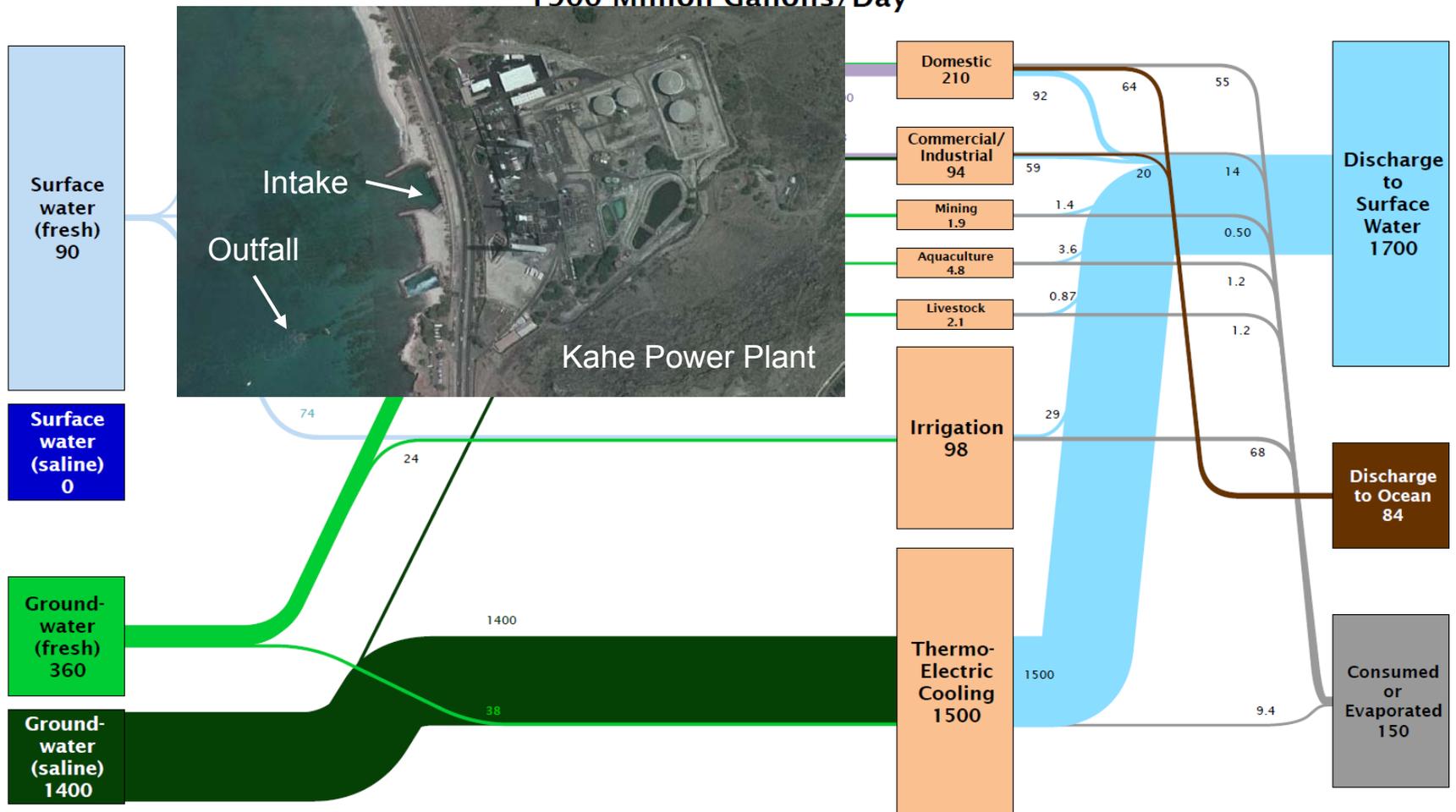
Accomplishments: State-level Water Flow

Estimated Hawaii Water Flow in 2005:
1900 Million Gallons/Day



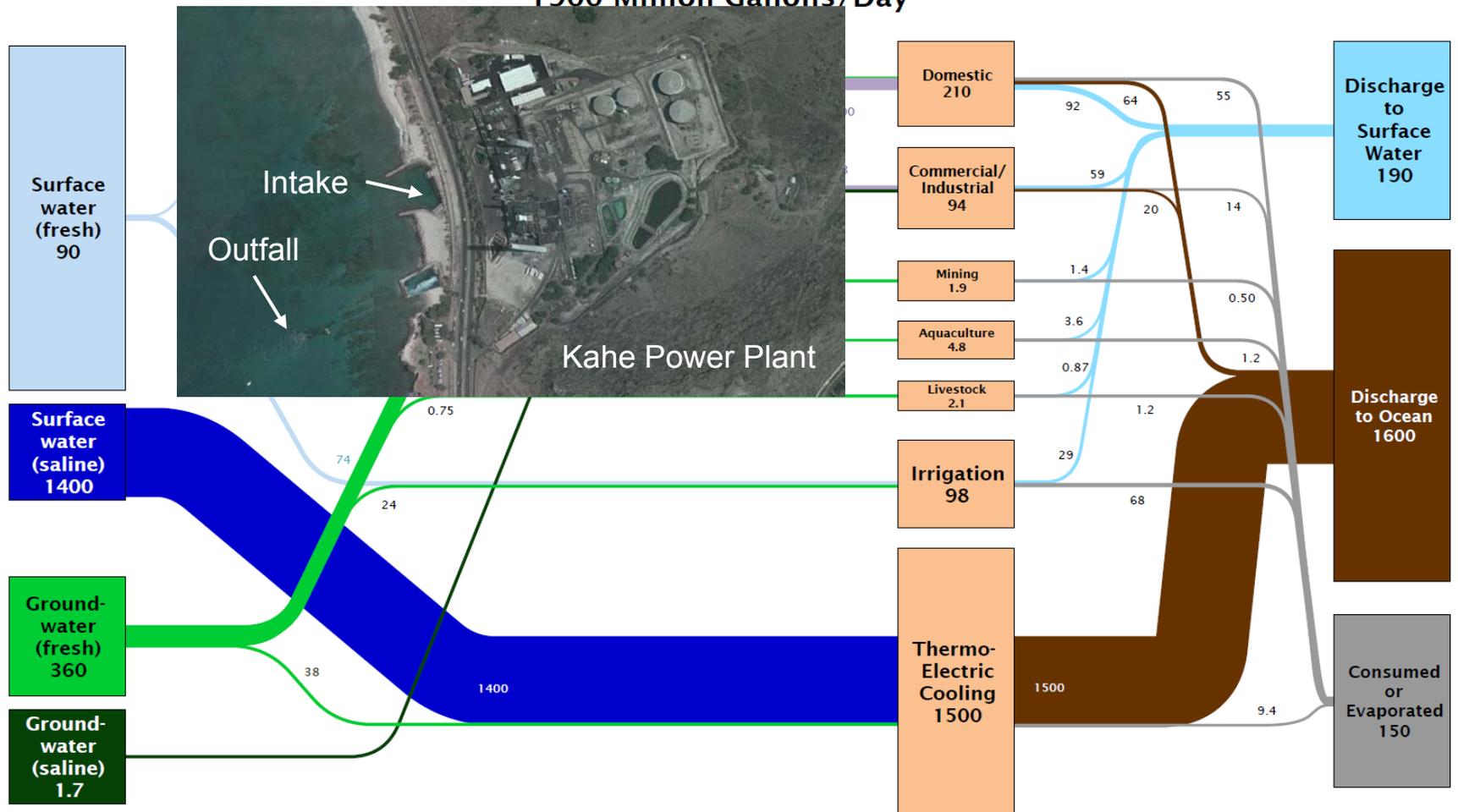
Accomplishments: State-level Water Flow

Estimated Hawaii Water Flow in 2005:
1900 Million Gallons/Day



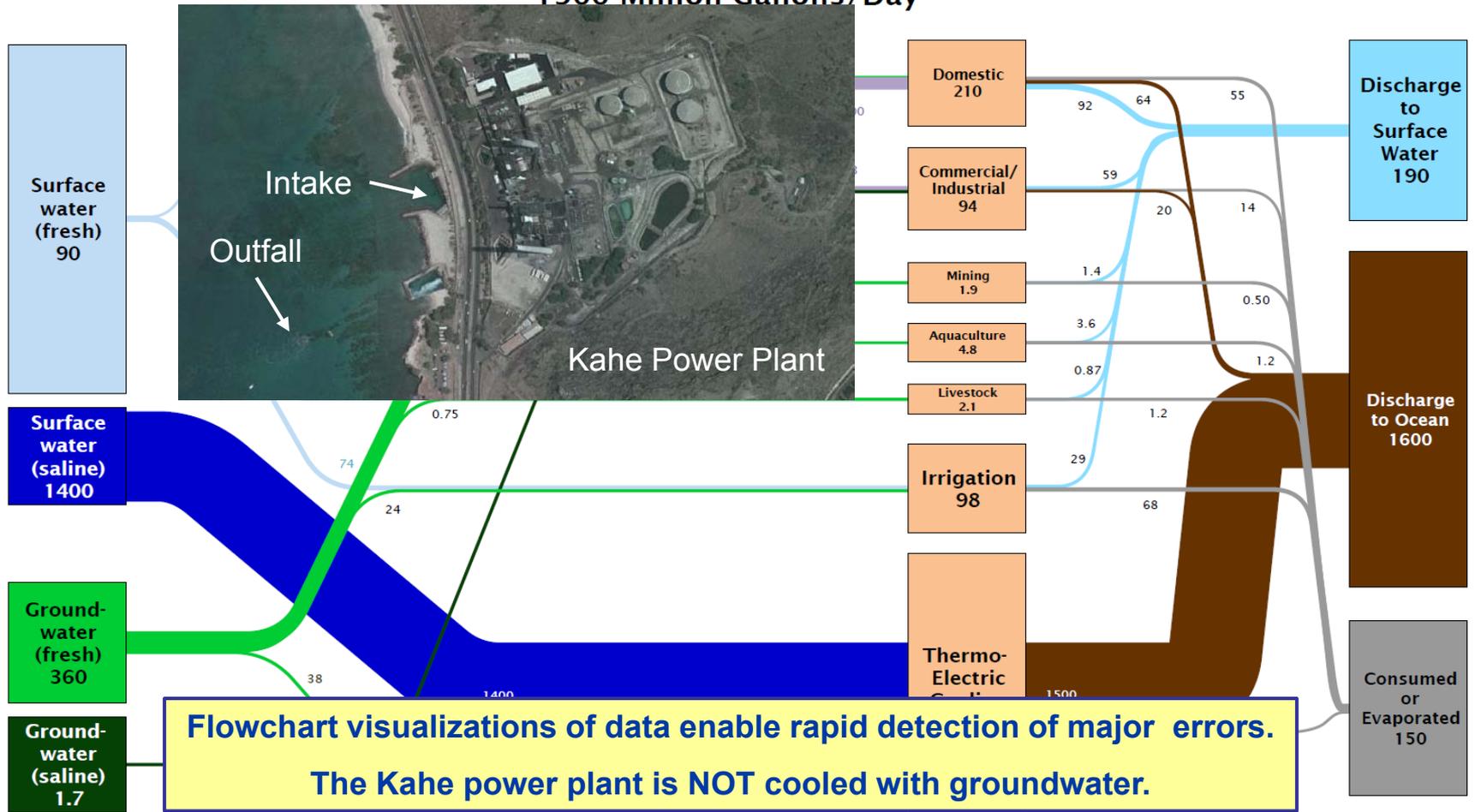
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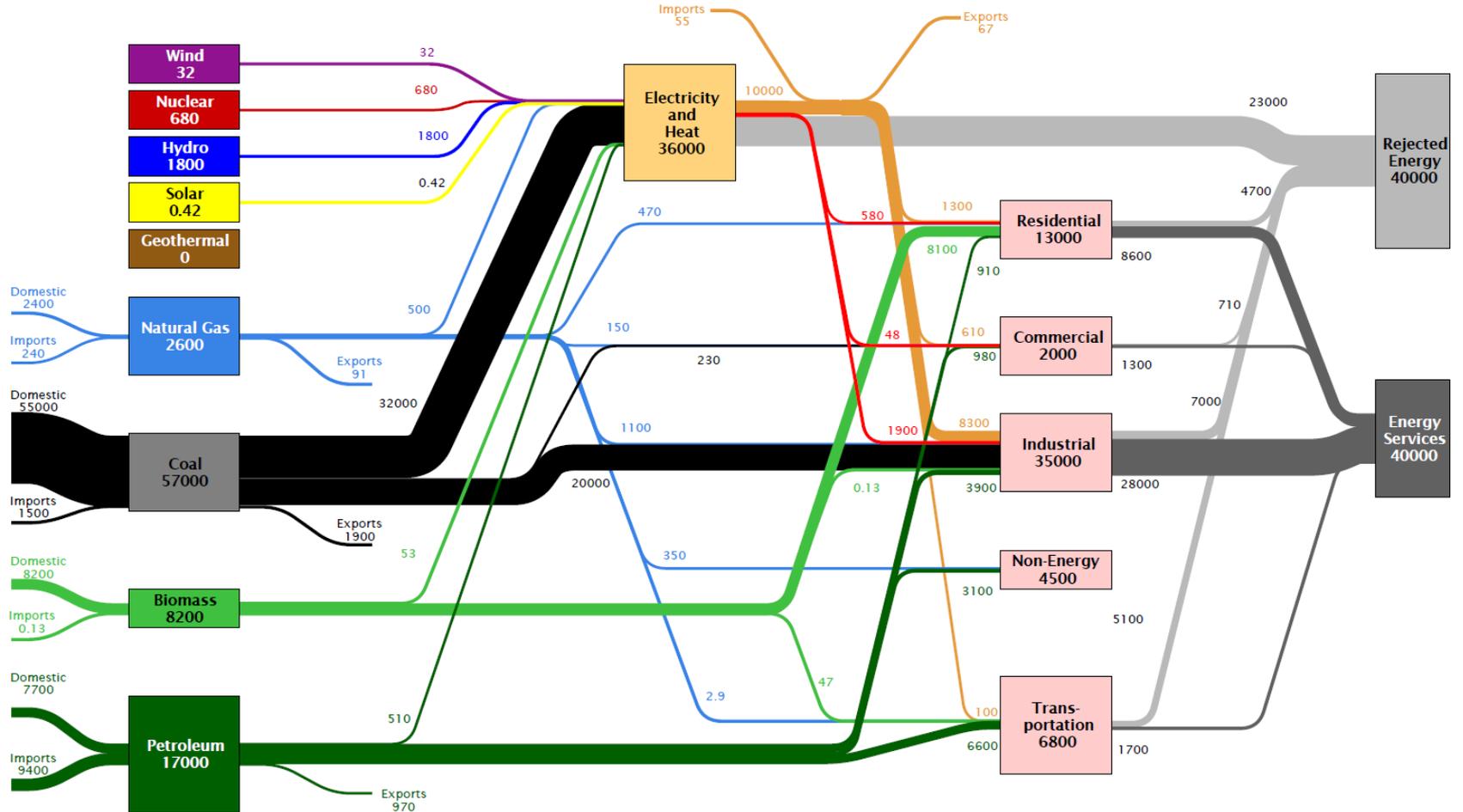


Flowchart visualizations of data enable rapid detection of major errors.
The Kahe power plant is NOT cooled with groundwater.



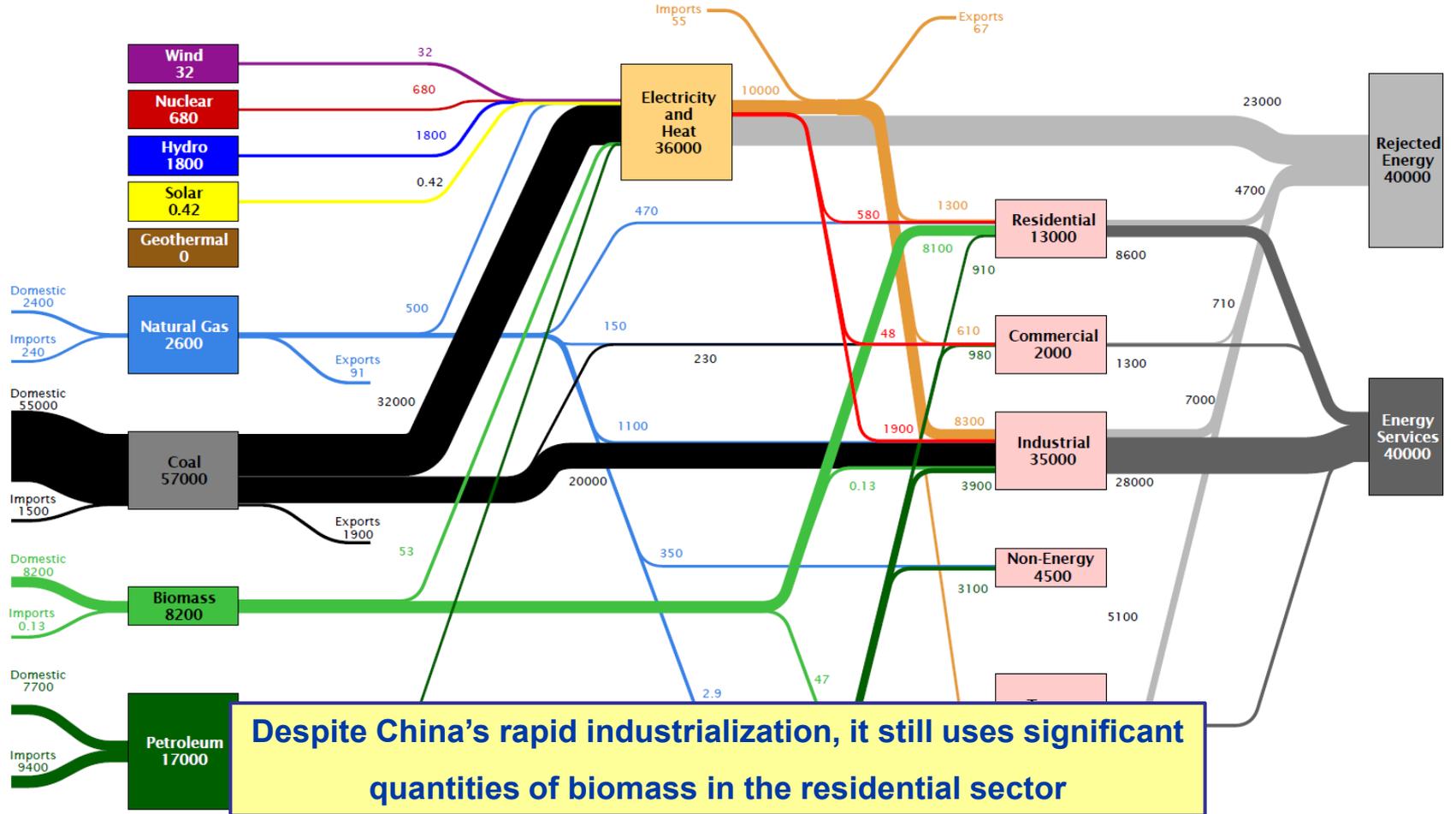
Accomplishments: International Energy Flow

China Energy Flow in 2007: ~85000 PJ



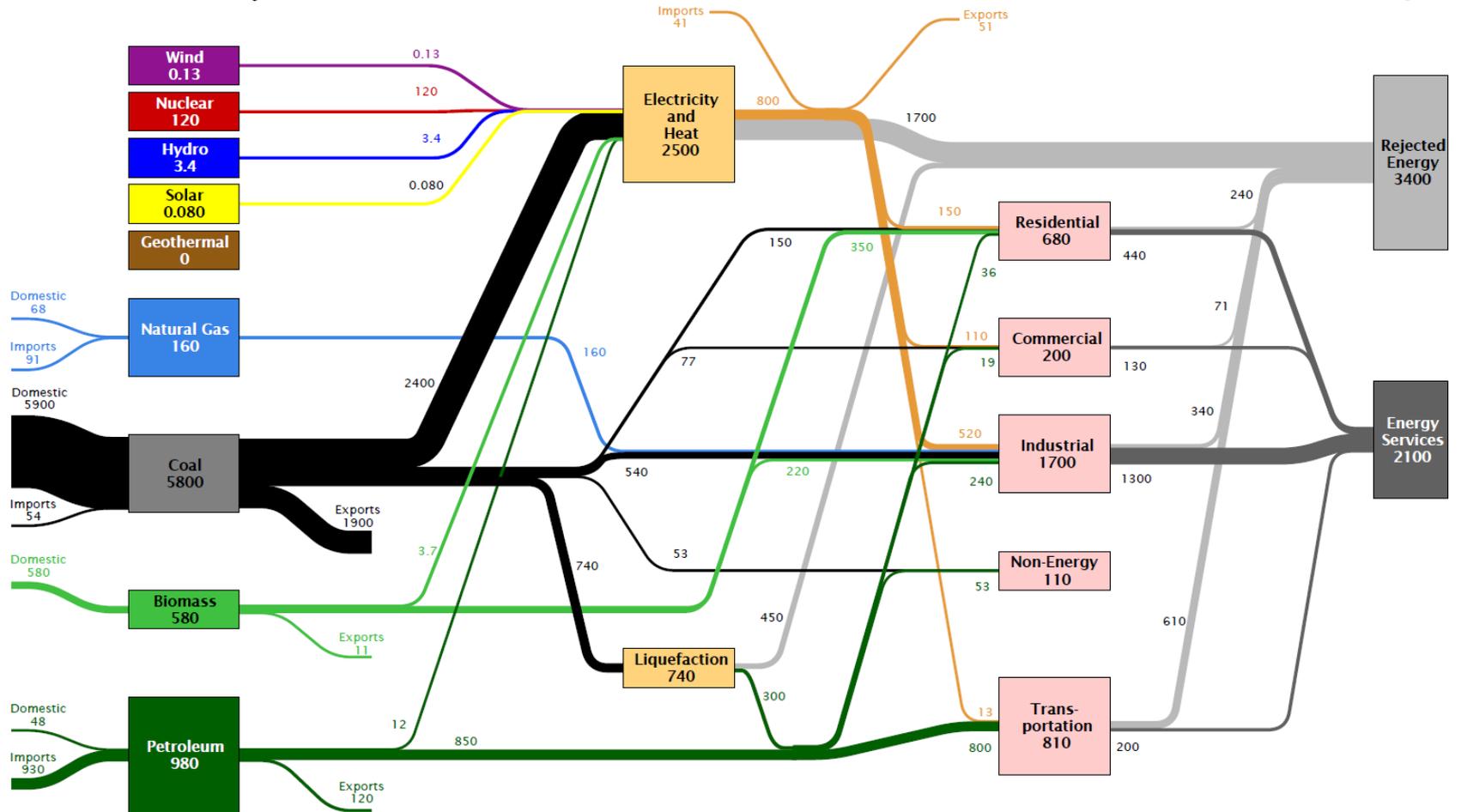
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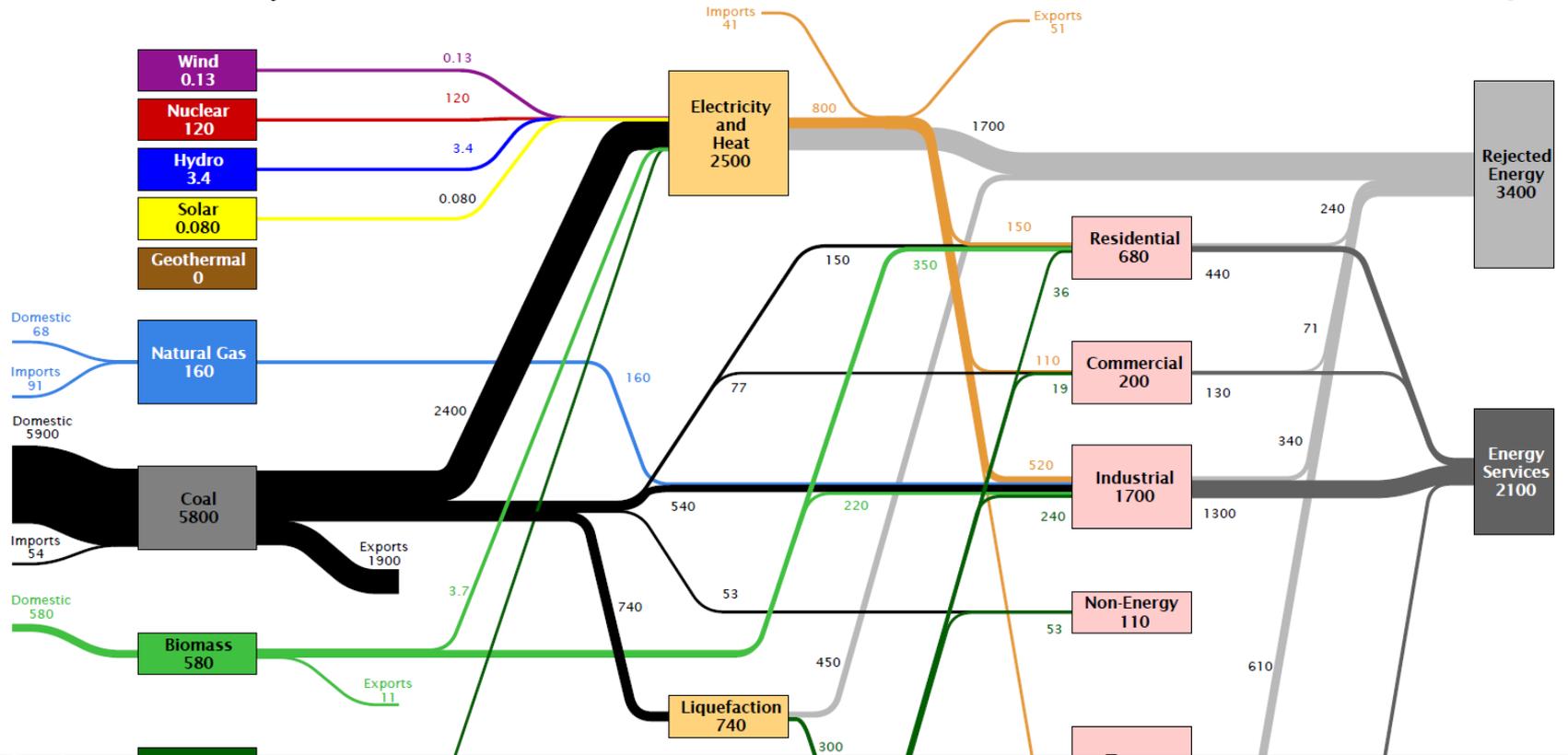
Accomplishments: International Energy Flow

South Africa Energy Flow in 2007: ~5600 PJ



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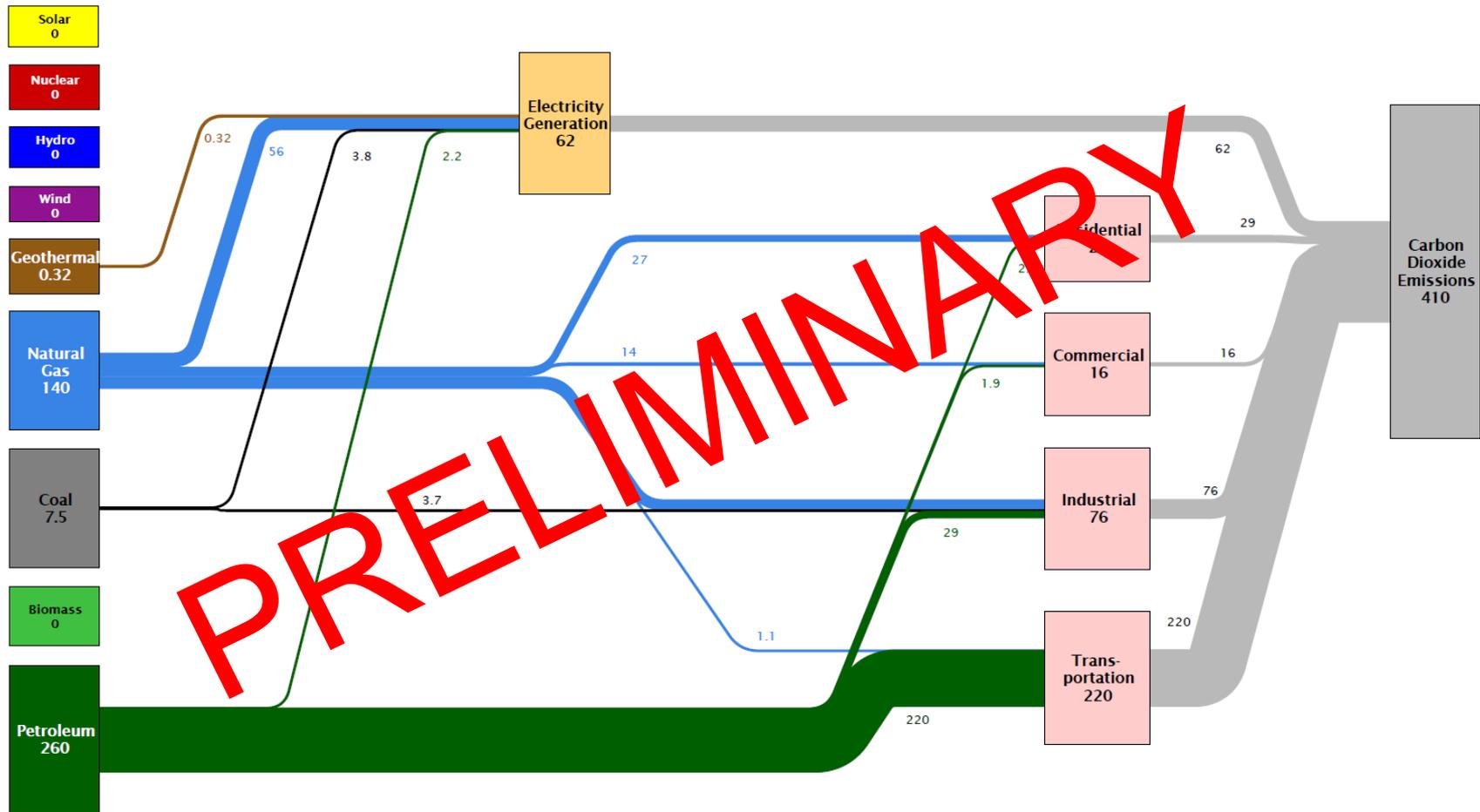


South Africa is the only country with a large enough coal liquefaction industry to warrant visualizing this sector. What will be the next country to see structural change?



Accomplishments: State-level CO₂

Estimated California Carbon Dioxide Emissions
in 2008: ~410 Million metric tons



Collaborations

- Past
 - NREL, Sandia
- This has been a transition year for LLNL's Hydrogen Analysis work and we intend to collaborate more broadly in FY12 and beyond.



Future Work

- Rest of FY11
 - Residential Energy Use (including advanced technology scenario)
 - Transportation Energy Use (including advanced technology scenario)
- FY12
 - Develop interactive versions for web
 - Industry: Manufacturing Energy Consumption Survey (MECS)
 - Global CO₂



Summary

- Conceptual maps of energy-critical mass flows complement other energy data products (tabular, geospatial, etc.)
- Local depictions of energy, water and carbon emissions are in demand by multiple stakeholders (policymakers, NGO's, technologists, etc.)
- These maps still require some manual “tuning” to be fully useful, but we are continuously improving our automation and workflow.
- Full results are available at <http://flowcharts.llnl.gov>

