Potential Indicators for the Energy System

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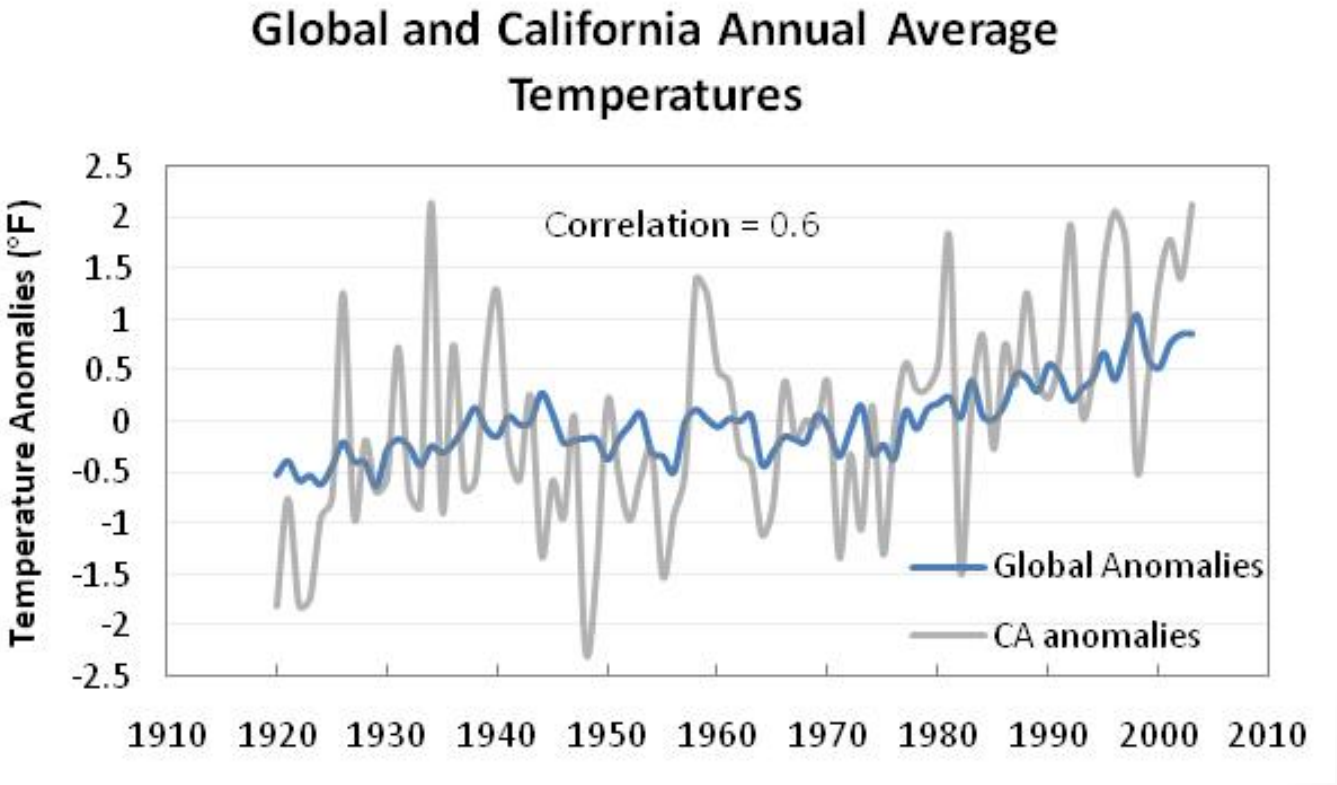
Desired Characteristics

- The energy indicators should:
  - Track progress on mitigation and/or adaptation with a good signal-to-noise ratio*.
  - Disentangle non-climatic features.
  - Be easy to understand and relevant to different levels of geographical detail (local to statewide).

* A comparison of the level of a desired signal (e.g., precipitation trend) to the level of background noise or natural variability (e.g., yearly precipitation changes).

Climate Variability Plays Large Role in "Small" Regions (e.g. CA)



Source: Franco and Oliver 2011 using data from NASA and WRCCC

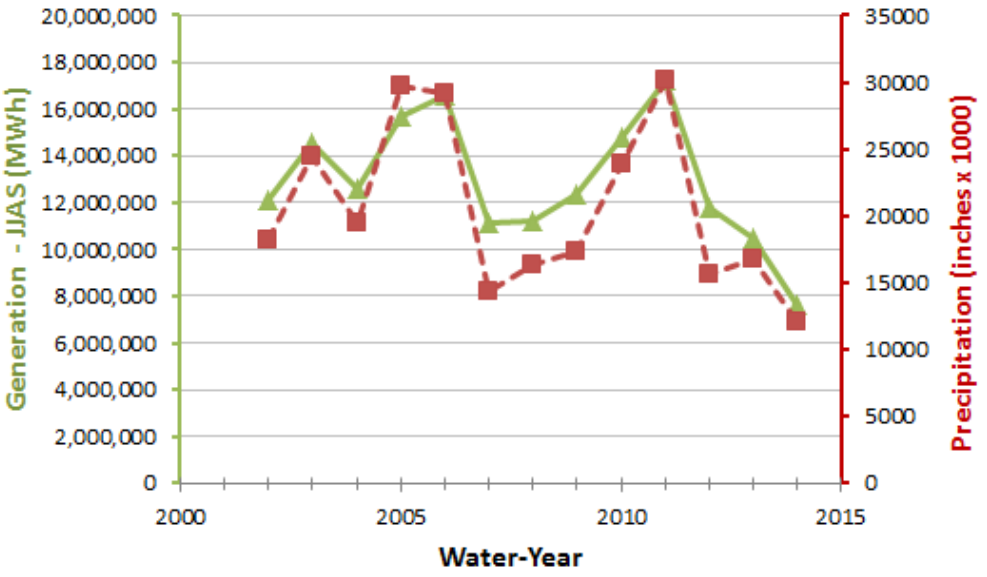
The signal-to noise ratio is better for the global average temperature than for the average temperature for California.

Potential energy indicators: some examples

Precipitation as a potential indicator for hydropower generation

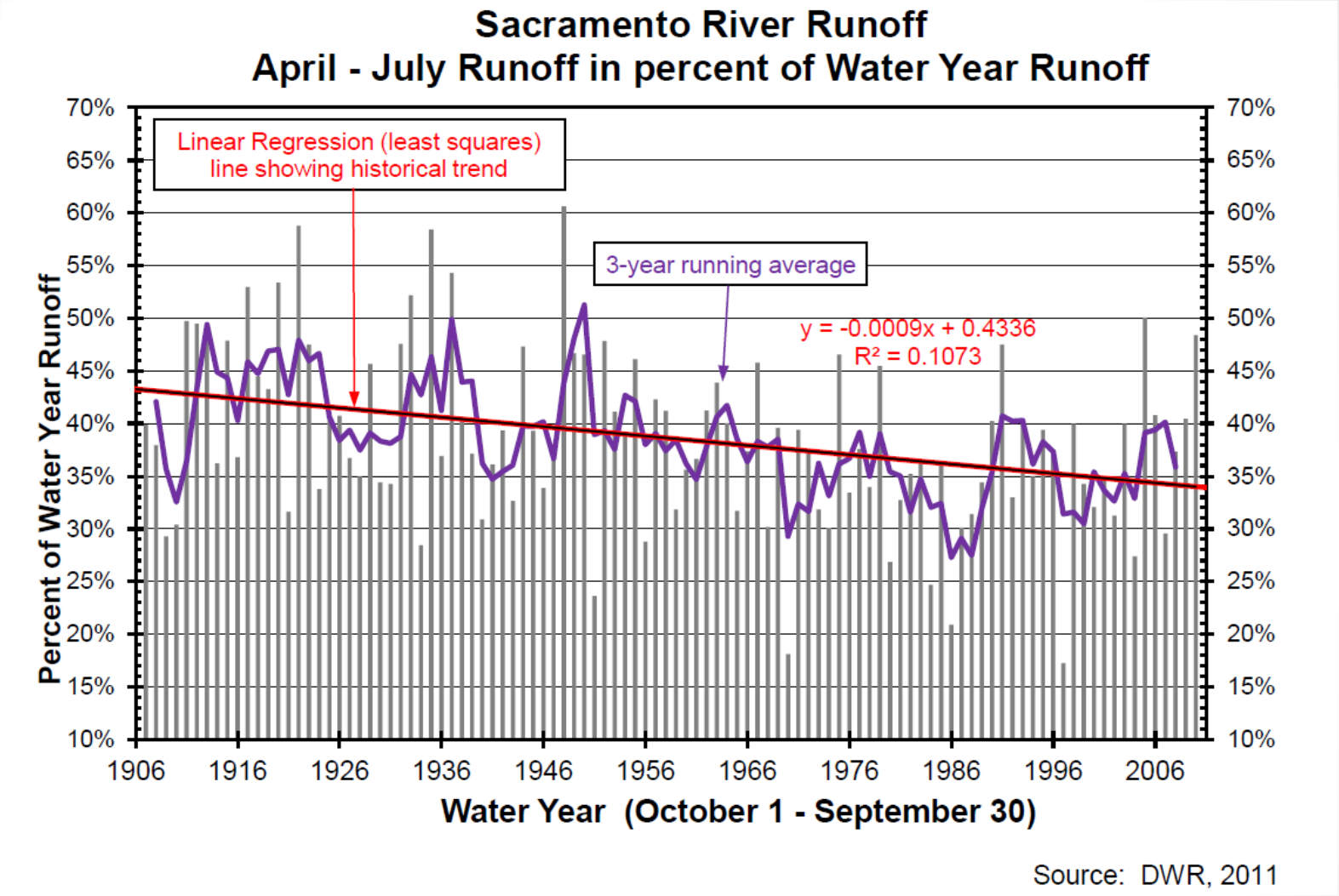
- Excellent correlation between hydropower generation from June 1 to September 30 to total water year precipitation (October 1 to September 30).
- However, study by Pierce and Cayan, 2012* indicates that other measures (e.g., fraction of winter precipitation that falls as snow) have a higher signal to noise ratio than precipitation.

Hydropower Generation from June to September and Water Year Precipitation: California



Data sources: EIA and WRCC

* Pierce, D. W., and D. R. Cayan, 2012: The uneven response of different snow measures to human-induced climate warming. J. Climate, v. 26, 4148-67.

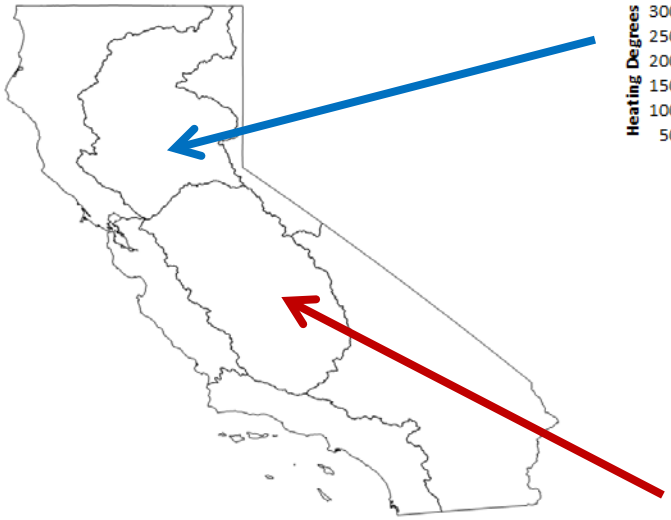


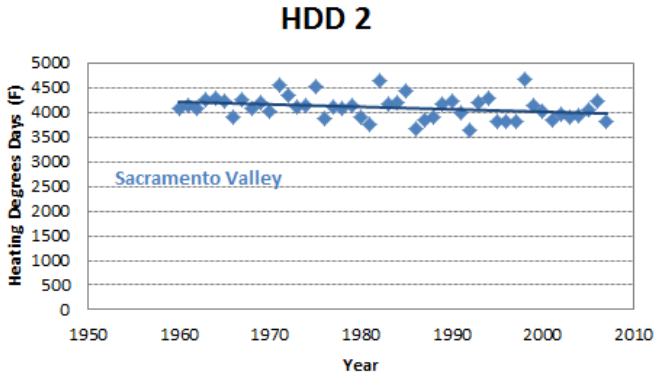
This may be a good indicator for hydropower, but other, more direct, indicators may be preferable such as generation in the summer months as a percentage of annual electricity generation. However, our preliminary analysis indicates that this is not the case. Water reservoirs confound the "signal," at least on a statewide basis.

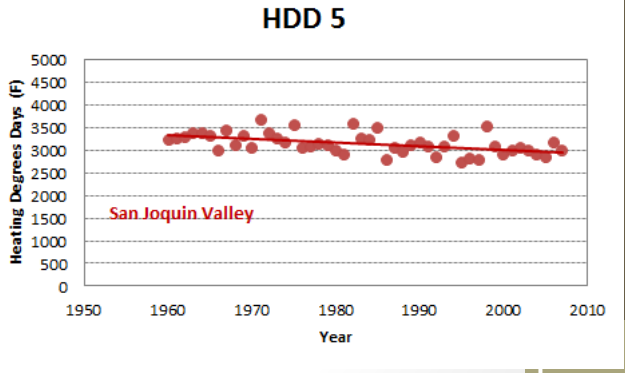
Cooling and Heating Degree Days (CDD & HDD): excellent indicators

- CDD and HDD are very useful indicators for the energy system because energy demand is approximately proportional to CDD and HDD.
- However, data from NOAA lacks sufficient geographical resolution or is at the station level and uses 65° F as the baseline temperature.

NOAA Climate Divisions: California



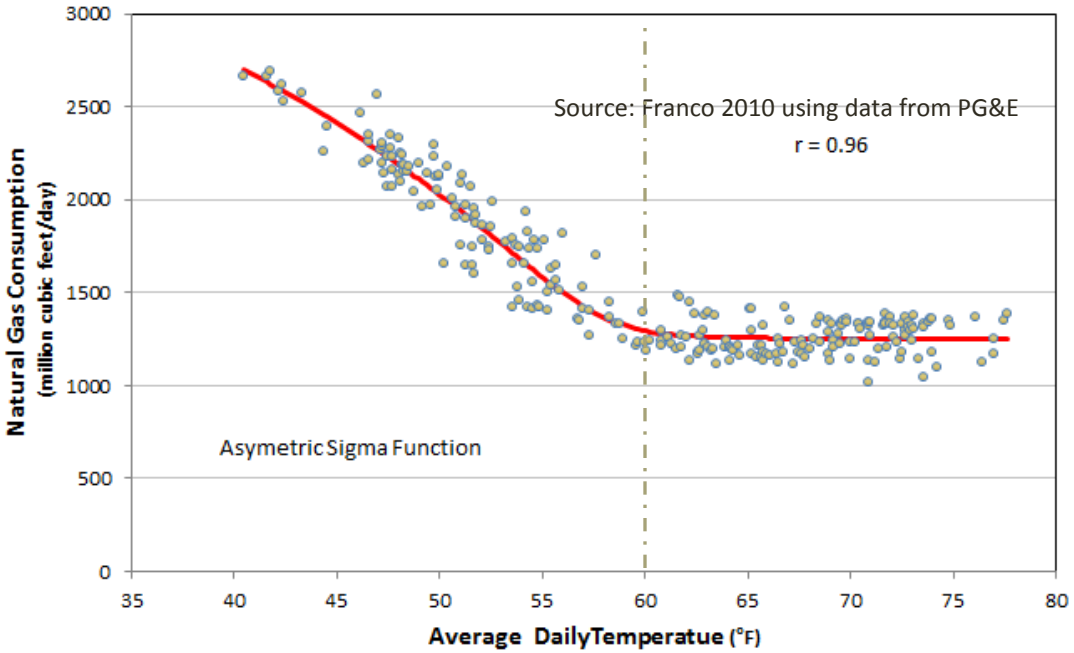




Source: Franco and Pineda, 2014 using data from NOAA

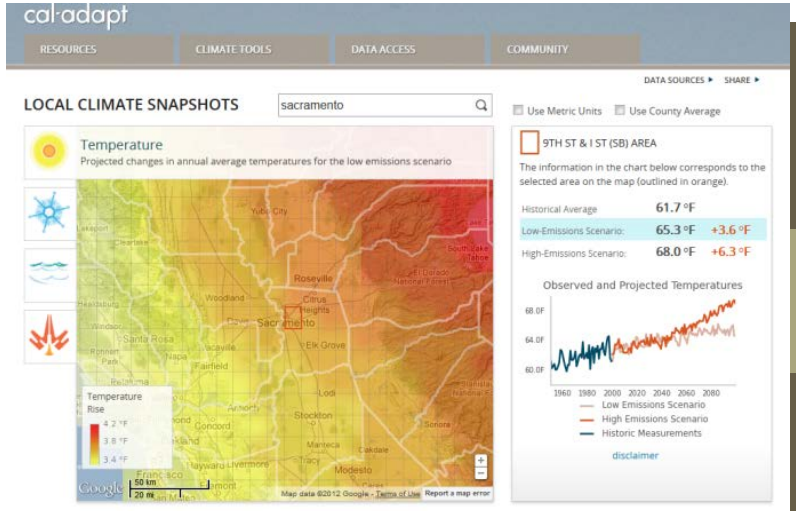
60° F may be a better Baseline Temperature for HDD for CA

- The graph shows that 60 °F is a better baseline temperature for gas consumption by core customers.



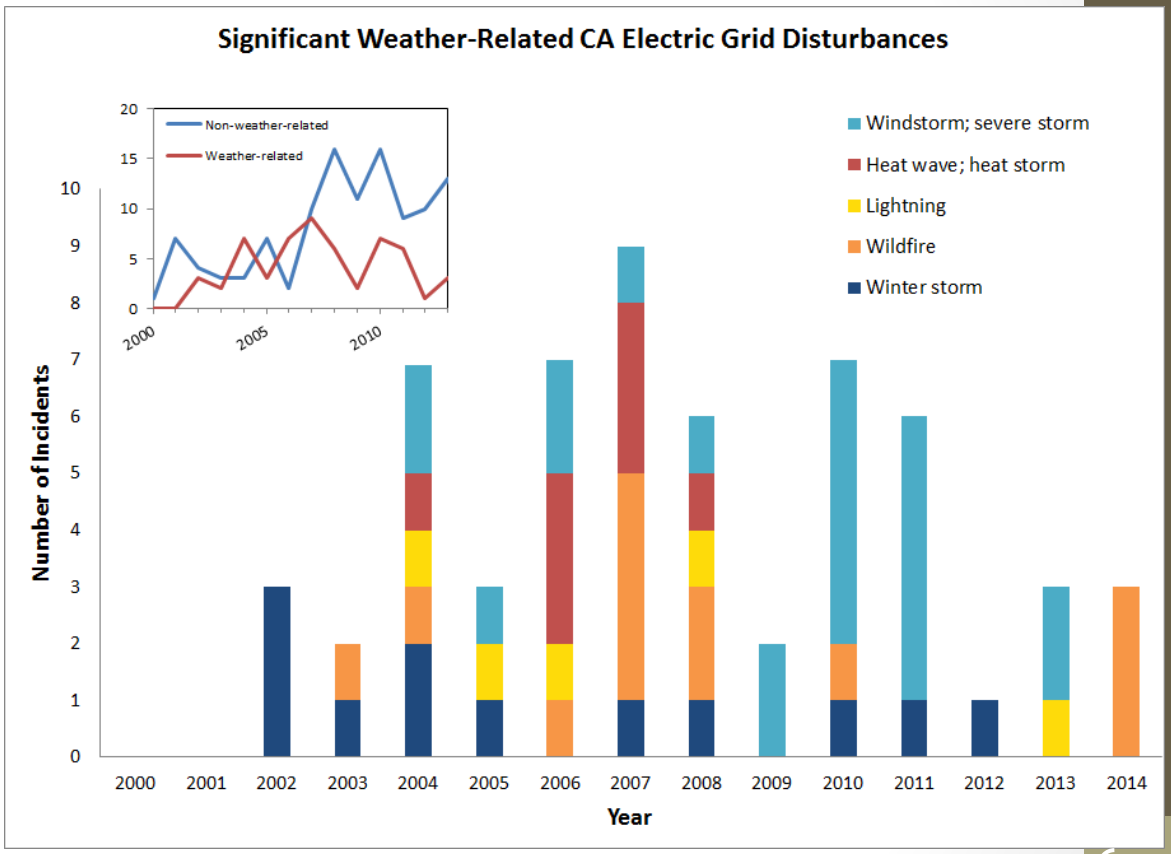
- Cal-Adapt will include CDD and HDD using grid resolutions of about 3.5 miles with different baseline temperatures including 60°F for HDD for the PG&E territory.

http://cal-adapt.org/



Weather-Related CA Electricity Grid Disturbances

- Data is available at the national level via EIA/DOE. Quality of the data may not be adequate to develop climate indicators.
- In a static system, weather-related grid disturbances should track changes in climate (e.g., heat waves) or weather related events (e.g., wildfires)
- However, our electricity system is changing. The aging/modernization of the grid can play a role in the observed trends.
- In addition, high climate variability in California can obscure trends.

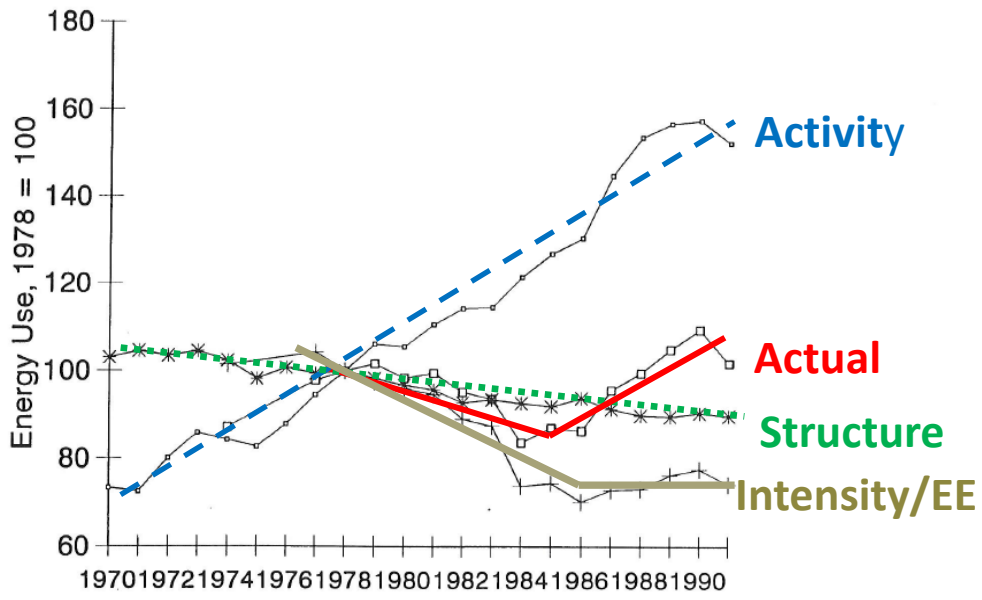


Source: Stoms, Franco, et al., staff paper. 2013 IEPR. Prepared and updated by L. Oliver and G. Franco in 2014. Data from EIA

Decomposition of Energy Consumption and CO_2 Trends

- Decomposition studies examine the factors affecting a given trend (e.g., actual energy consumption). The figure shows that energy efficiency programs and the move to less energy intensive industries (structural changes) dampened the potential increases of energy due to the rise of industrial activity.
- Decomposition studies are very difficult to undertake but extremely informative. Estimation of trends controlling for "external" factors is an important area of future research.
- Some of the factors to include in the decomposition analyses are: changing climatic conditions (e.g., HDD), economic growth, and population growth.

Figure 4.2
Delivered Energy Use in California Manufacturing
Impact of Changes in Activity, Structure, and Intensity



Source: Energy Efficiency in California: A Historical Analysis. Lee Schipper and James McMahon. **July 1995**

Other Potential Energy Indicators

- Weather-related indicators for the natural gas system.
- Weather-related indicators for the network providing transportation fuels (e.g., pipelines, refineries).
- Hydropower and timing and amounts of streamflows at the local/regional scales.
- Embedded energy/GHG consumption/emissions from economic activities in California.
- Trends in wind regimes and solar fluxes are very important for renewable sources of energy but data are sparse and of dubious quality.
- Coastal fog regimes and coastal upwelling trends, which affect energy demand in our coastal cities.
- Tully fog in the Central Valley affecting heating demand.
- Trends of other meteorological and hydrological factors (e.g., relative humidity, water temperatures, water availability for cooling of power plants).

Conclusions and Recommendations

- The energy indicators should:
  - Track progress on mitigation and/or adaptation with a good signal-to-noise ratio.
  - Disentangle non-climatic features.
  - Be easy to understand and relevant to different levels of geographical detail.
- There is a need for scientific research to support the development of policy-relevant energy indicators (2013 IEPR)

Thank you!

Panchito Franco

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