

# Calliope Energy Systems Modeling Framework

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2nd Open Energy Modelling Initiative Workshop  
14th April, 2015



# Simple fantasy model

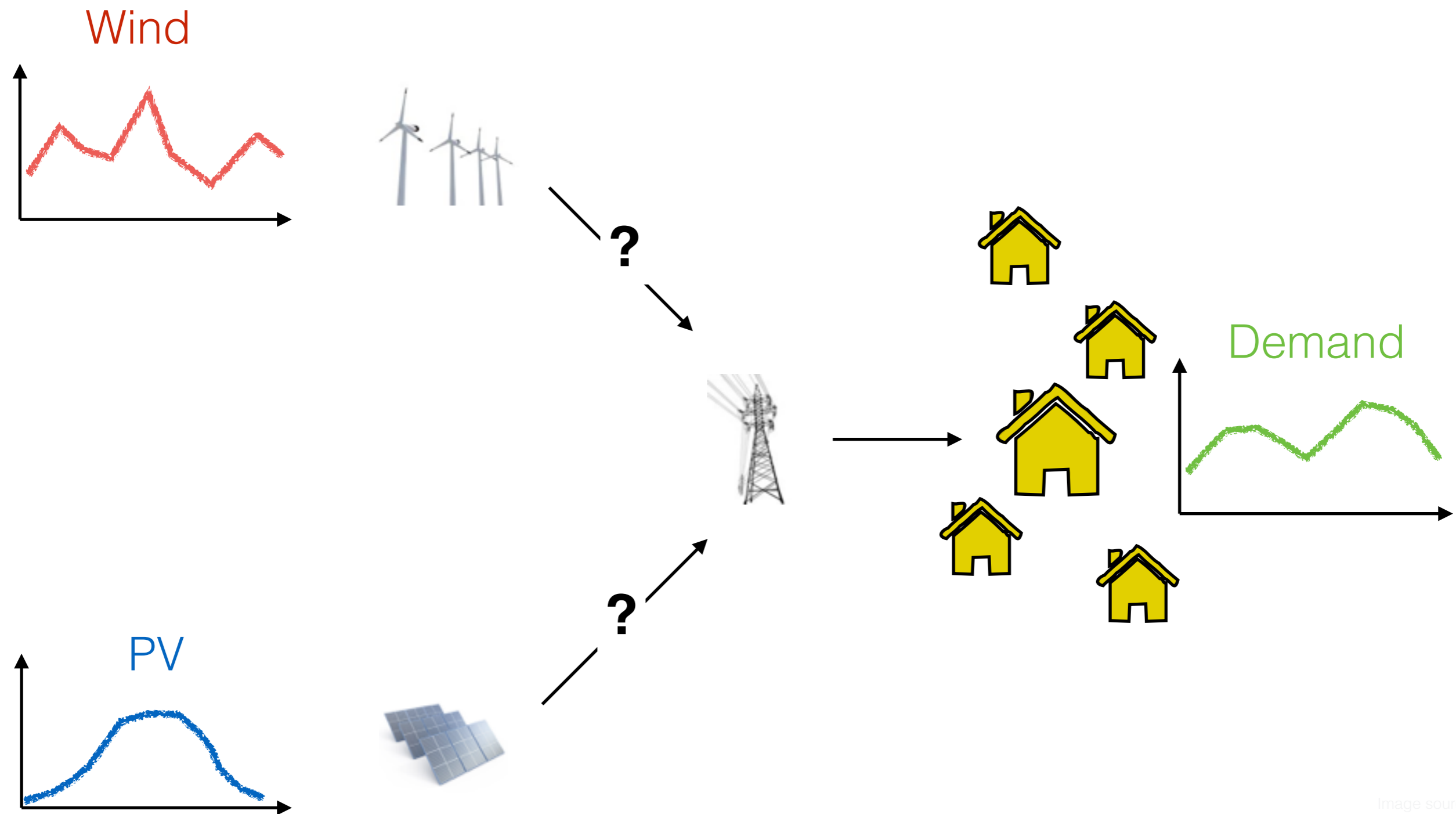
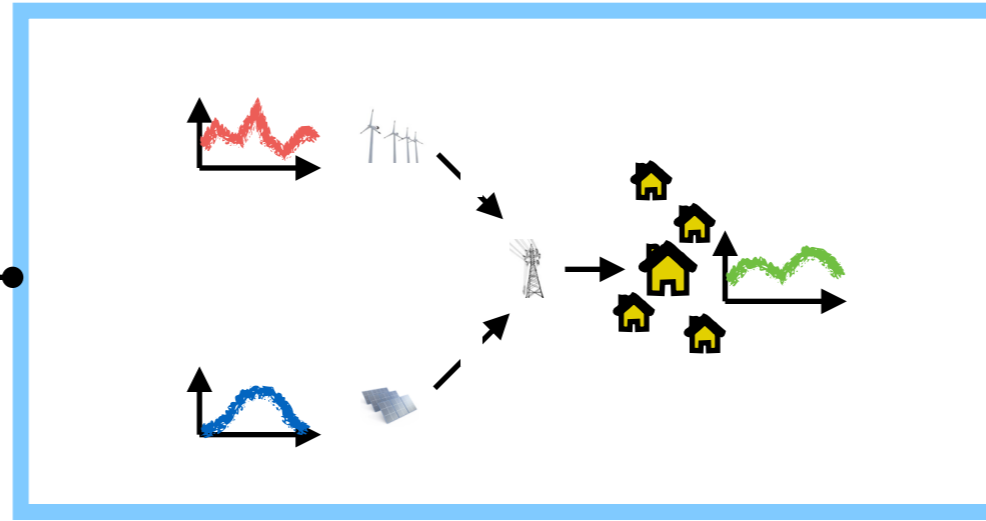


Image sources:  
<http://ncptt.nps.gov/wp-content/uploads/fire-vector.png>  
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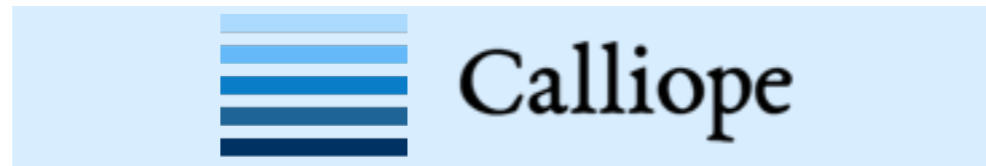
# Calliope Rationale and Design Decisions

- Separate most code (“framework”) from data (“model”)
- Model configuration and data easily human-readable, machine-processible and version-trackable: CSV and YAML
- High spatial and temporal resolution; dynamic time resolution
- Hybrid planning-operational models
- Able to run on high-performance computing clusters for sensitivity analysis
- As many free/open components as possible

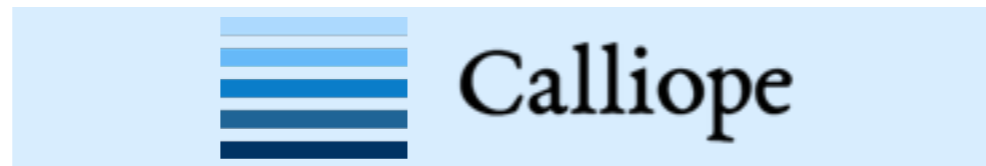
Input data ("model")



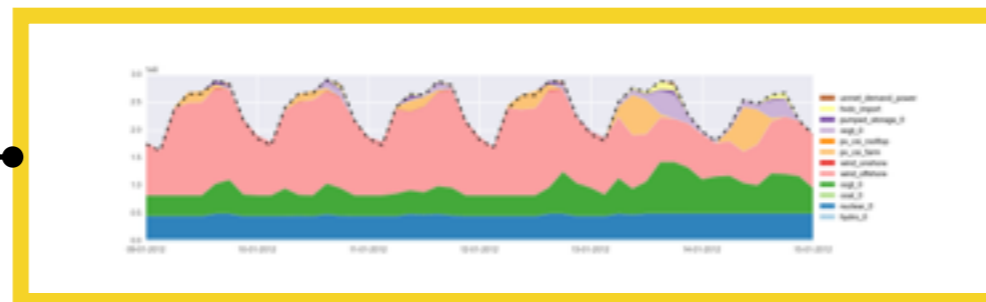
Optimization:  
(commercial) solver



$$\begin{aligned} & \text{maximize } \begin{bmatrix} S_1 & S_2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \\ & \text{subject to } \begin{bmatrix} 1 & 1 \\ F_1 & F_2 \\ P_1 & P_2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \leq \begin{bmatrix} L \\ F \\ P \end{bmatrix}, \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \geq \begin{bmatrix} 0 \\ 0 \end{bmatrix}. \end{aligned}$$



Results and analysis:  
Tables and graphs



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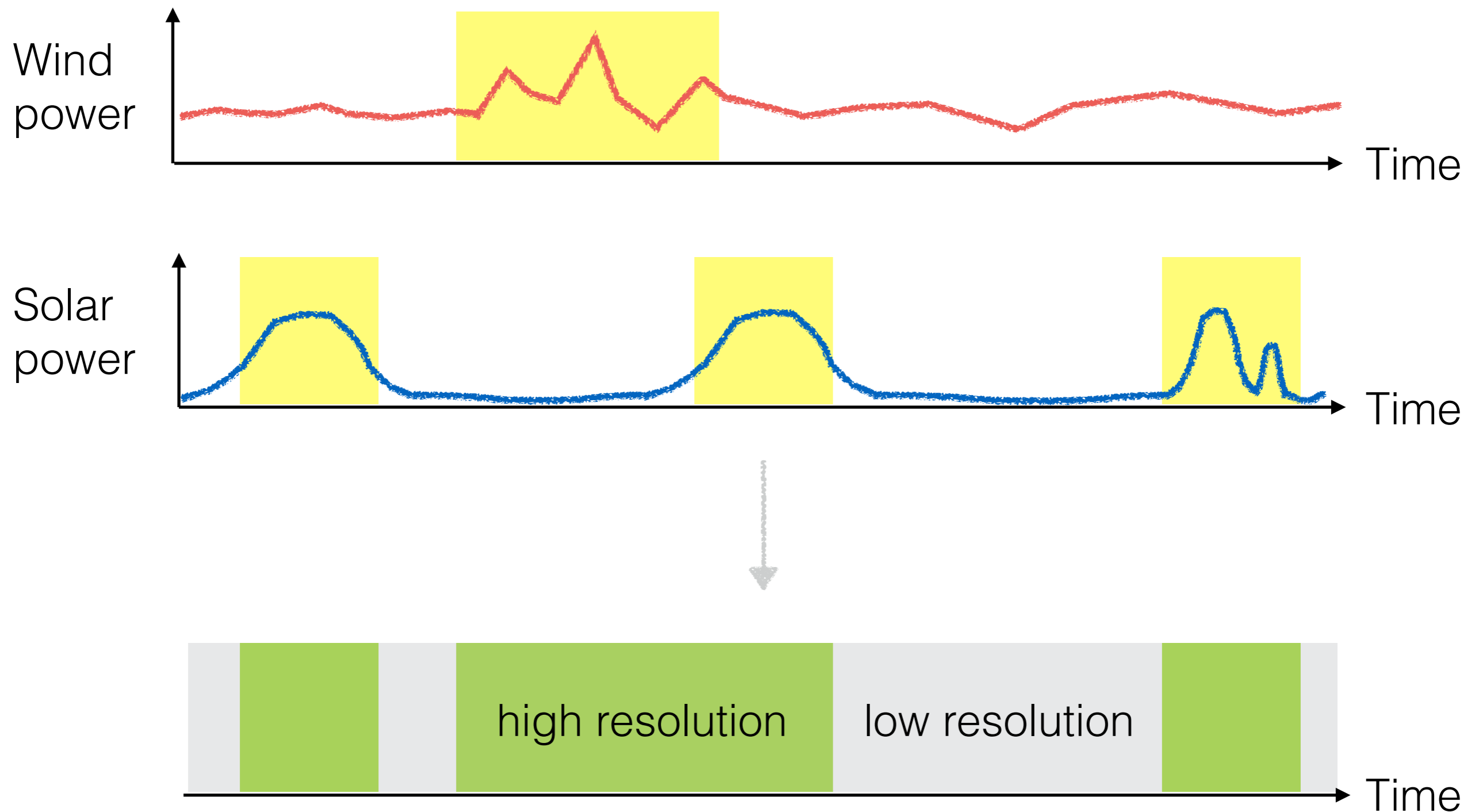
# YAML configuration example

```
techs:
  nuclear:
    name: Nuclear
    color: '#9087EE'
    parent: supply_power
    constraints:
      r: inf
      e_ramping: 0.2
    costs:
      monetary:
        e_cap: 3029.5
        om_var: 0.0005
        om_fixed: 60
        om_fuel: 0.005
      co2:
        om_var: 0.012
```

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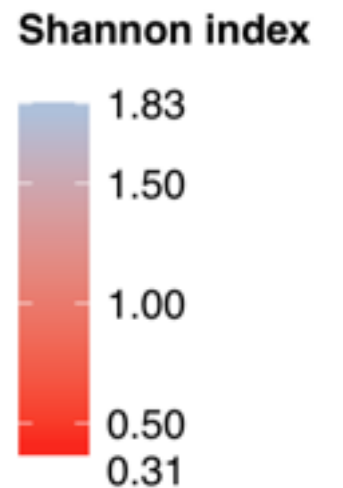
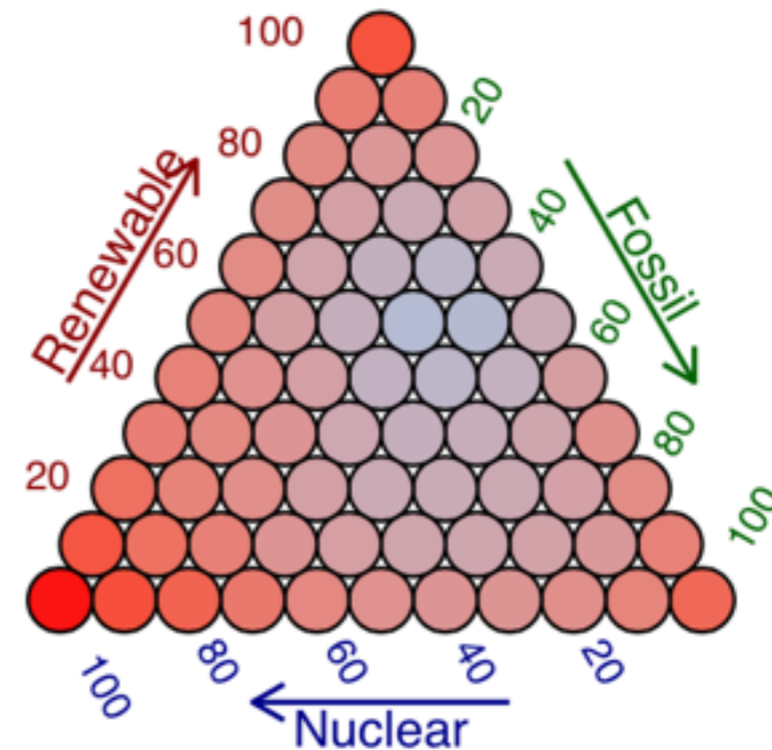
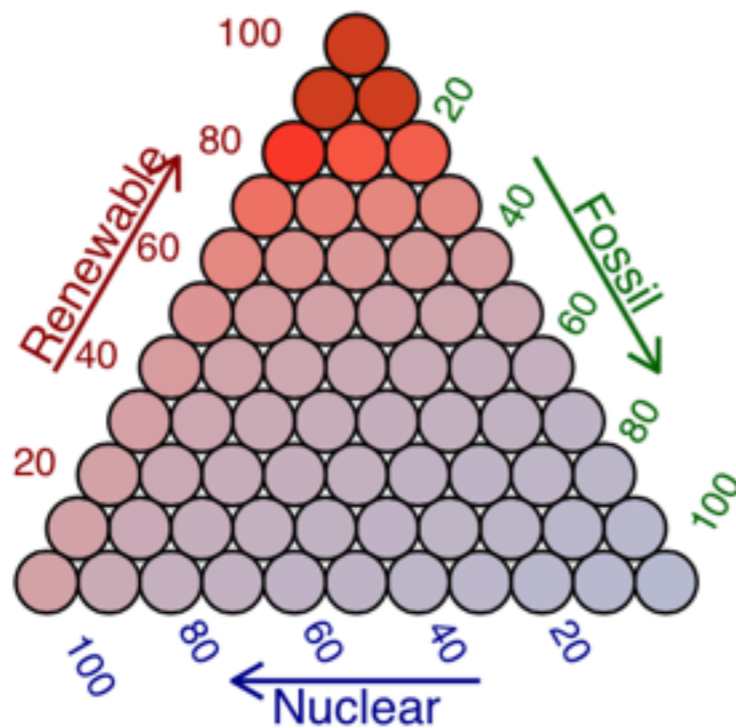
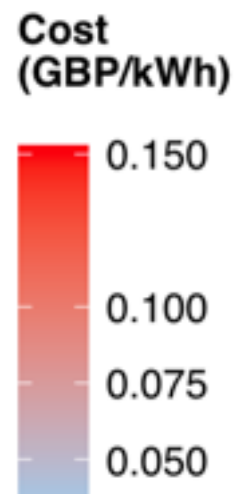
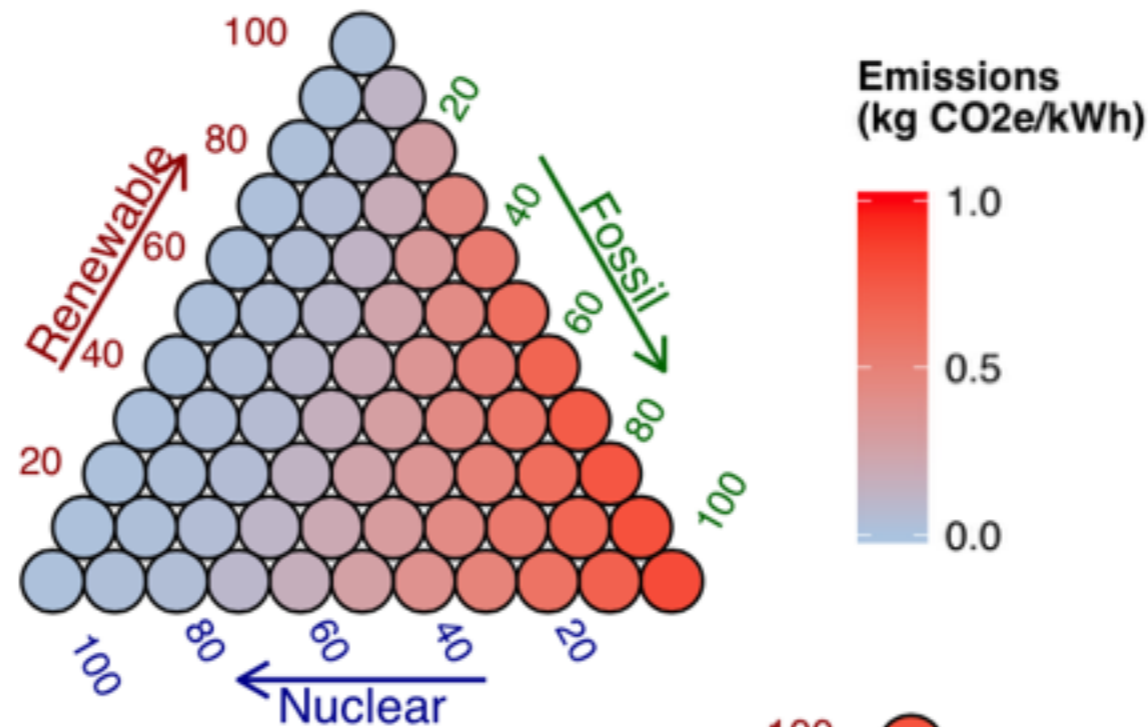
# Dynamic timesteps



# Calliope Rationale and Design Decisions

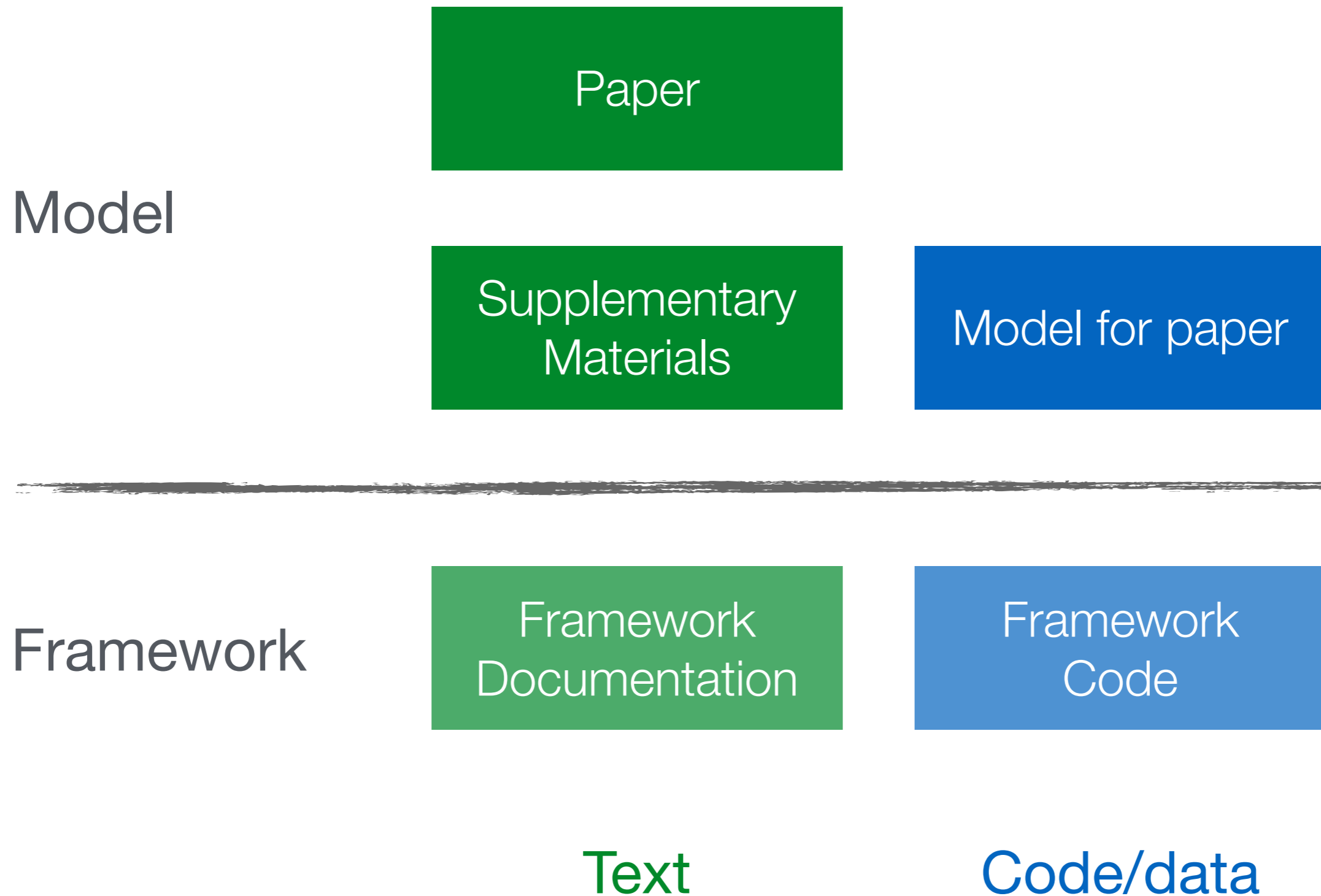
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# Scenarios for the UK power system




Stefan Pfenninger and James Keirstead. "Renewables, nuclear, or fossil fuels? Scenarios for Great Britain's power system considering costs, emissions and energy security." Submitted to Applied Energy (under review).


# Thoughts on going open source (1)



# Thoughts on going open source (2)

 [setup.py](#)

Specify Python 3 only in setup.py

 **README.rst**

build passing

coverage 61%

license Apache 2.0

pypi v0.3.3

## Calliope

*A multi-scale energy systems (MUSES) modeling framework*

Project website: [www.callio.pe](http://www.callio.pe)

DOI for the most recent stable version on Zenodo: DOI [10.5281/zenodo.105281](https://doi.org/10.5281/zenodo.105281)

[www.github.com/calliope-project/calliope](https://www.github.com/calliope-project/calliope)

# Contact

Sign up for emails on new releases:

<http://goo.gl/forms/I2RqGXCpfs>

Email: [s.pfenninger12@imperial.ac.uk](mailto:s.pfenninger12@imperial.ac.uk)

Project website and documentation: [www.callio.pe](http://www.callio.pe)

Project code: [www.github.com/calliope-project/calliope](http://www.github.com/calliope-project/calliope)  
(Apache 2.0 license)