



# Interoperability between models: the next bottleneck in energy planning

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June 15th, 2026

# We (almost) solved the modelling problem. Now we face the integration problem.

- ✓ Climate models
- ✓ Demand models
- ✓ Capacity Expansion Models
- ✓ Production Cost Models
- ✓ Power Flow Models
- ✓ Market Models
- ✓ Other



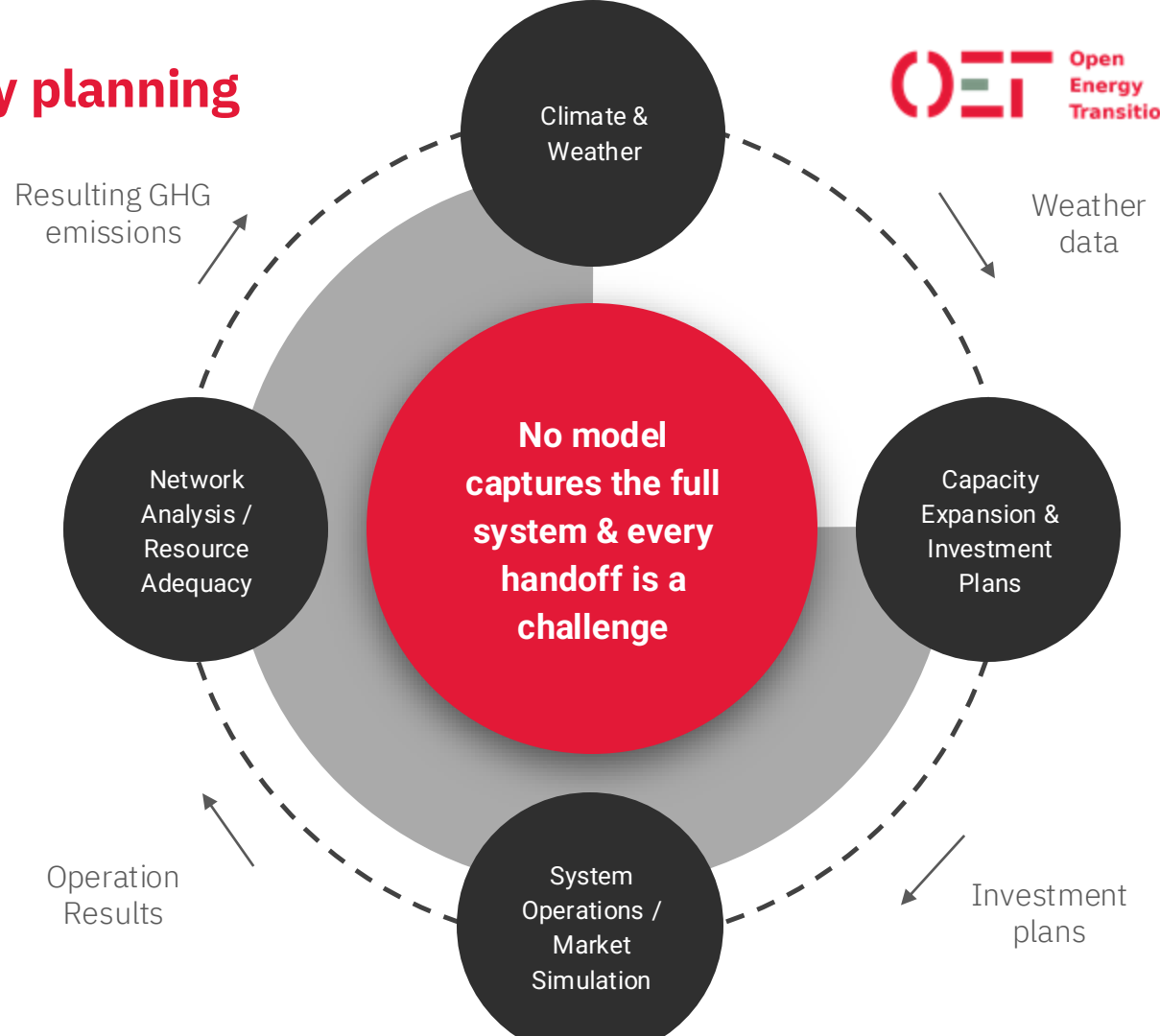
- ✗ Different formats
- ✗ Different assumptions
- ✗ Different spatial resolutions
- ✗ Different ownerships
- ✗ Different update cycles

**The challenge:  
connecting them**

# The complexity of energy planning

## Modelling domains are increasingly interdependent

- Planning assumptions depend on climate, demand, technology, and network information
- Operational results can challenge investment assumptions
- Network constraints can change what looks optimal at system level



# Examples of Cross-Domain Energy Planning Problems

	Plant flexibility	Climate impacts	High renewables
Energy Planning Question	What is the impact of power plant flexibility on system operations?	How will climate change affect future power systems?	What transmission upgrades are required for 80% renewable generation?
Answer requires	<ul style="list-style-type: none"> <li>- Plant-level Model</li> <li>- Production Cost Model</li> </ul>	<ul style="list-style-type: none"> <li>- Climate Model</li> <li>- Capacity Expansion Model</li> <li>- Production Cost Model</li> </ul>	<ul style="list-style-type: none"> <li>- Capacity Expansion Model</li> <li>- Production Cost Model</li> <li>- Power Flow Model</li> </ul>
Hand-off information	Unit constraints ↓ Dispatch inputs	Weather Data ↓ Demand/resource profiles	Expansion plans ↓ Dispatch schedules ↓ Power flow

# What is interoperability?

**Interoperability** is the ability of independent modelling tools and domains to exchange, interpret, and use information consistently in a coordinated analysis.

## 3 Dimensions of Interoperability

### Technical

Can information be exchanged?

### Semantic

Is information interpreted consistently?

### Governance

Can the data flow be trusted and maintained?

# What can go wrong when models interact?

## 3 Dimensions

### Technical

Can information move?

- X CSV's don't match
- X Manual data transformations
- X Broken workflows

### Semantic

Is information be understood?

- X Different definitions
- X Different assumptions
- X Missing context

### Governance

Can the data flow be trusted and maintained?

- X No ownership
- X No documentation
- X Limited access
- X No maintenance

Most interoperability issues appear in the handoff: what is exchanged, what it means, and who maintains it → Weak handoffs create weak analysis, even when the individual models are strong.

# What does good interoperability look like?

## Technical

Standard interfaces

Automated workflows

Machine-readable formats

## Semantic

Shared definition

Common metadata

Aligned assumptions

## Governance

Clear ownership

Documentation

Version control

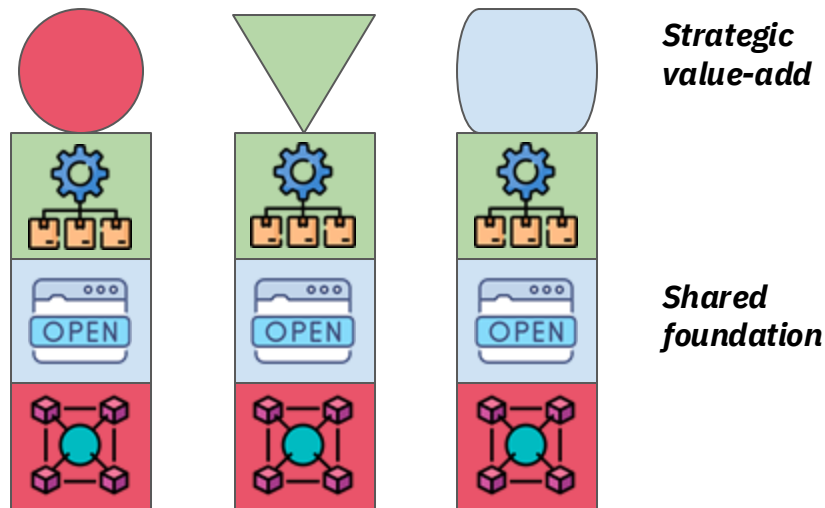


Information can be exchanged, understood, and trusted.

# The role of open source in interoperability

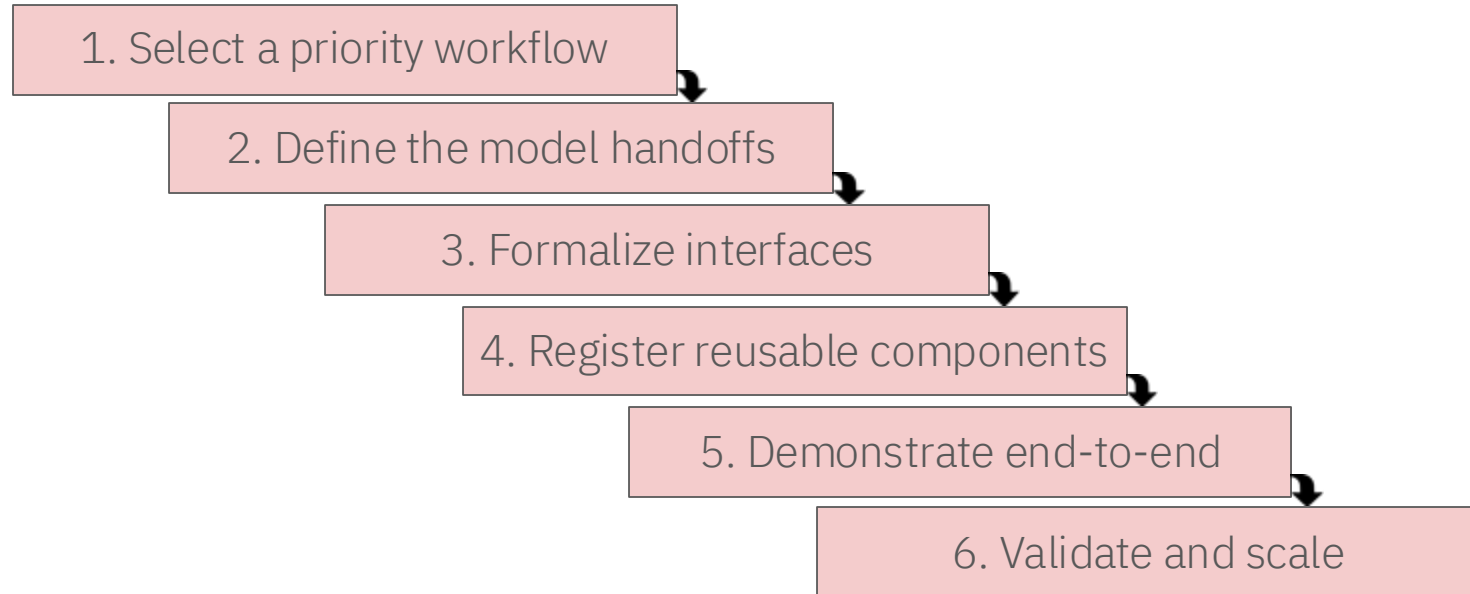
Open source as an enabler for an interoperable, shared, inspectable, and reusable ecosystem.

- Interfaces can be inspected, tested, and trusted
- Tools can align around common data structures
- New tools and domains can be added over time
- Analyses can be rerun, reviewed, and improved
- Teams can choose and adapt tools across platforms



# The Way Forward

The way forward is to turn priority model handoffs into reusable workflows that can be executed, validated, and expanded.





# Thank you!



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