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Integrated Energy Planning Model

Bill Lakos – Energy Analyst

Tuesday, February 4, 2014

Goals related to energy use:

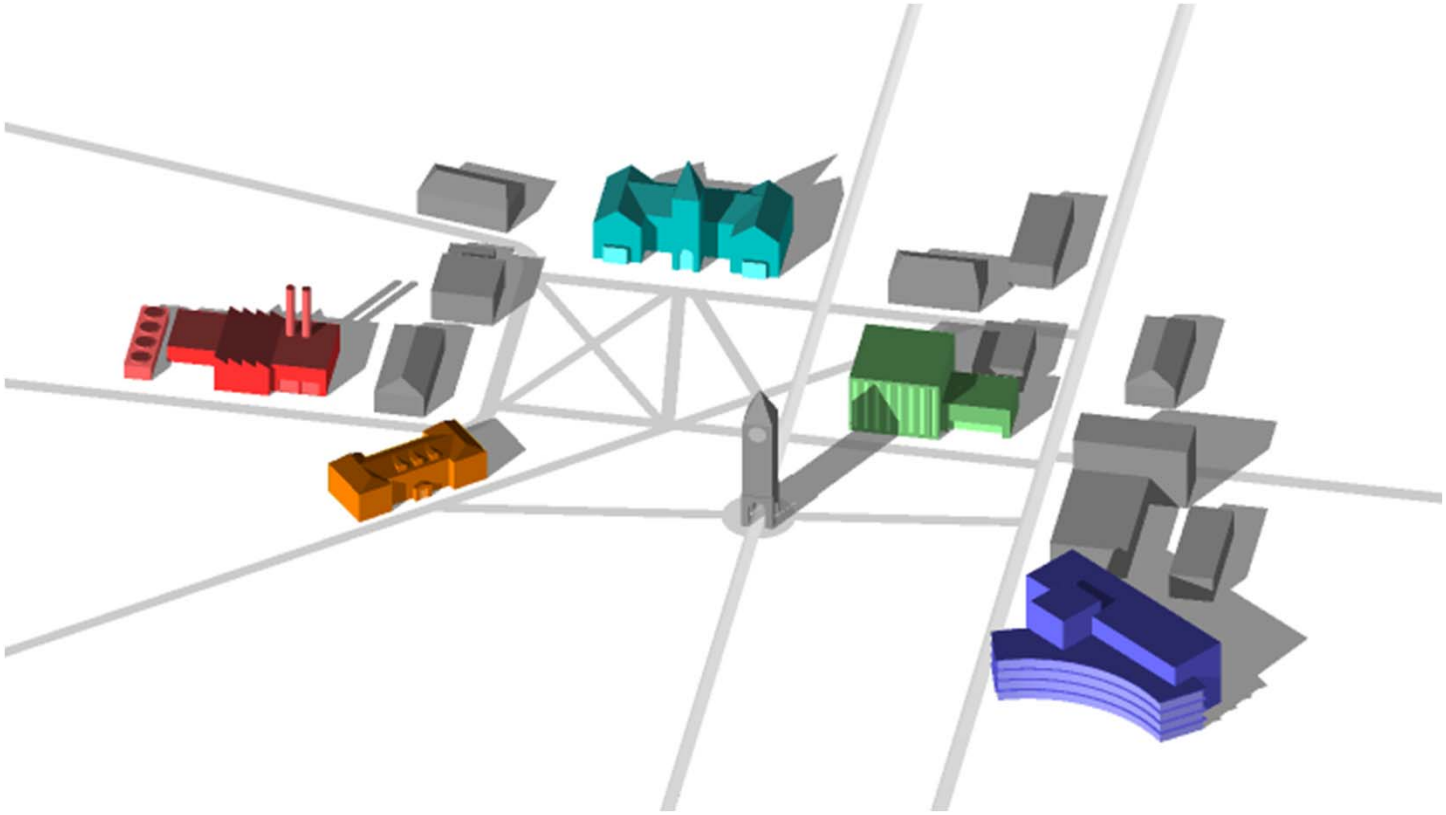
- Greenhouse gas reduction
- Environment
- ACUPCC / Carbon neutrality
- Regulatory Compliance
- Renewable Energy
- Reduce cost
- Reduce price volatility
- Reduce financial exposure
- Health
- Research
- Education

SHARED INSIGHTS CLEAR DIRECTION

The breadth of complexity defies individual expertise

The rate of change outpaces normal experience

Increasing Pace and Complexity



Increasing Pace and Complexity

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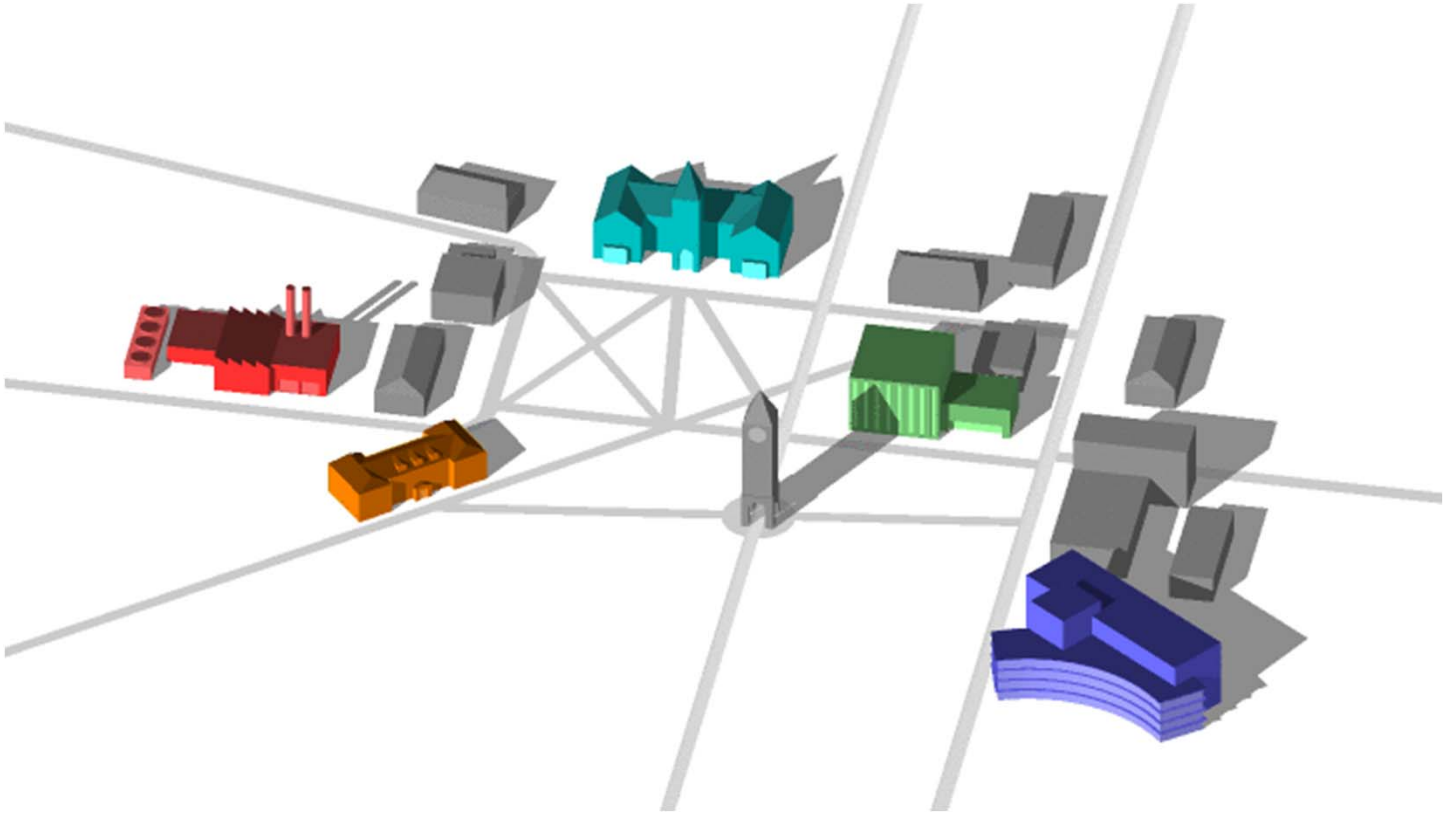

Increasing Pace and Complexity

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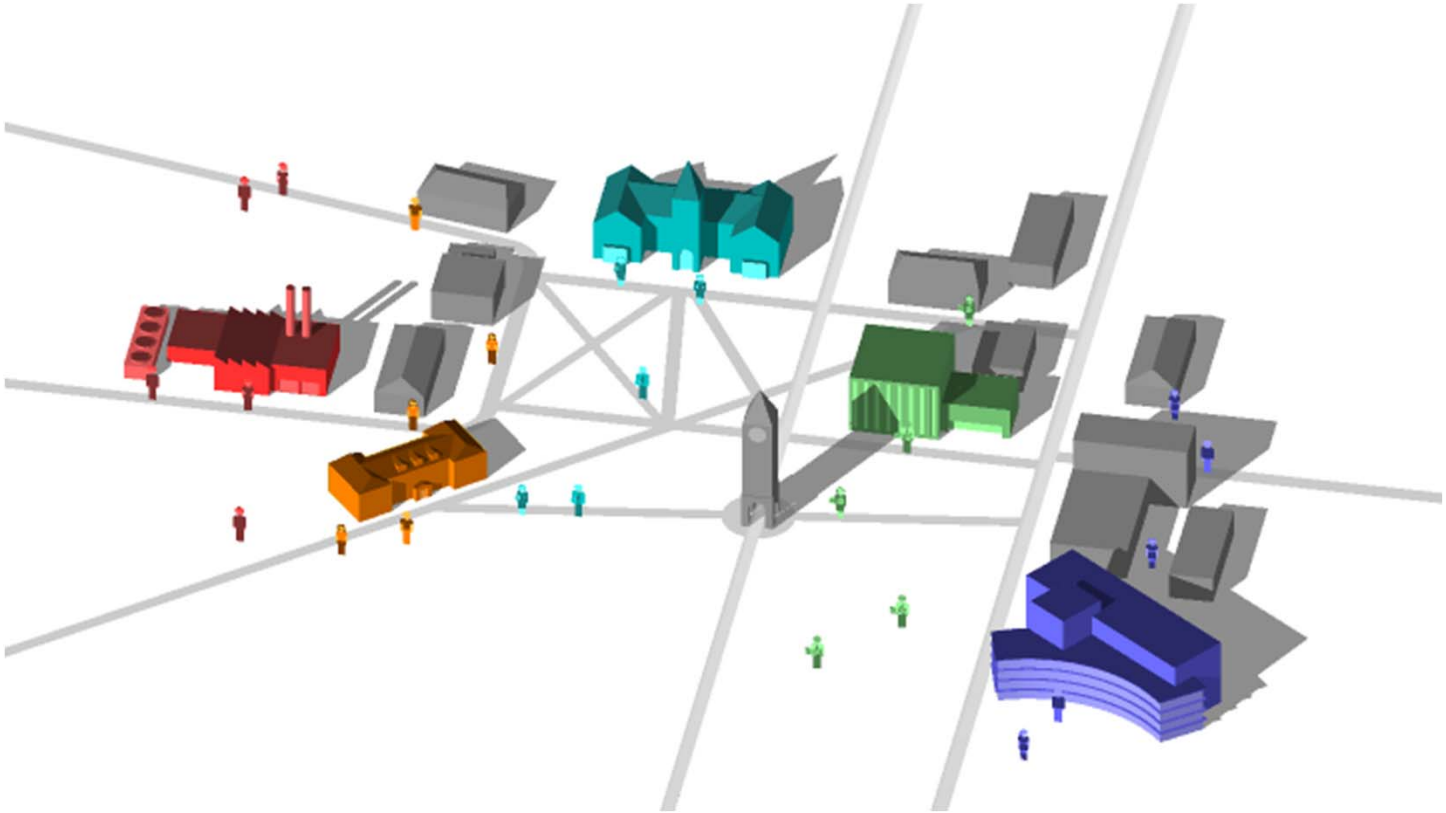

Increasing Pace and Complexity

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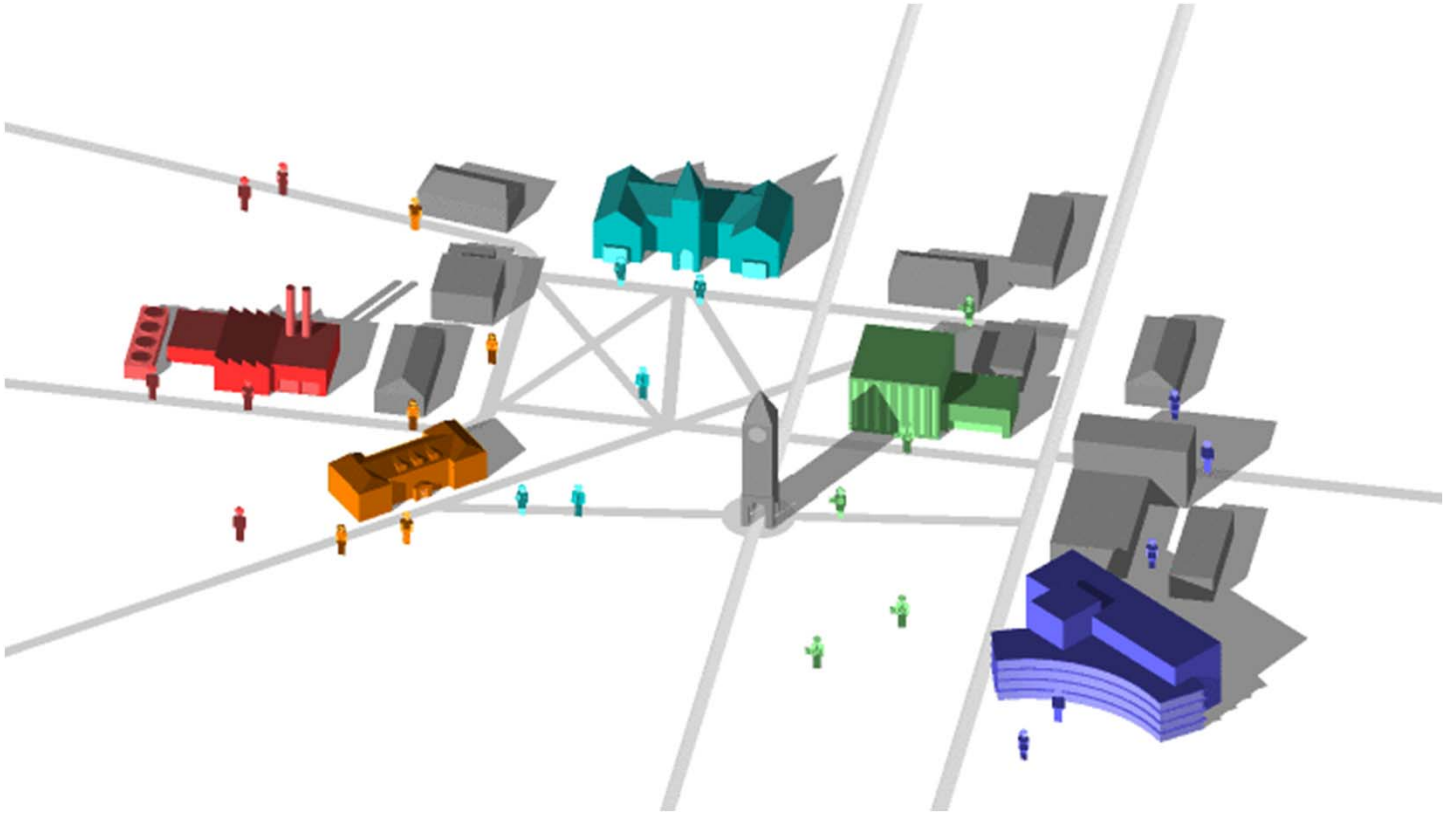

Increasing Pace and Complexity

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Increasing Pace and Complexity

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Increasing Pace and Complexity

Capacity and Capital Investments

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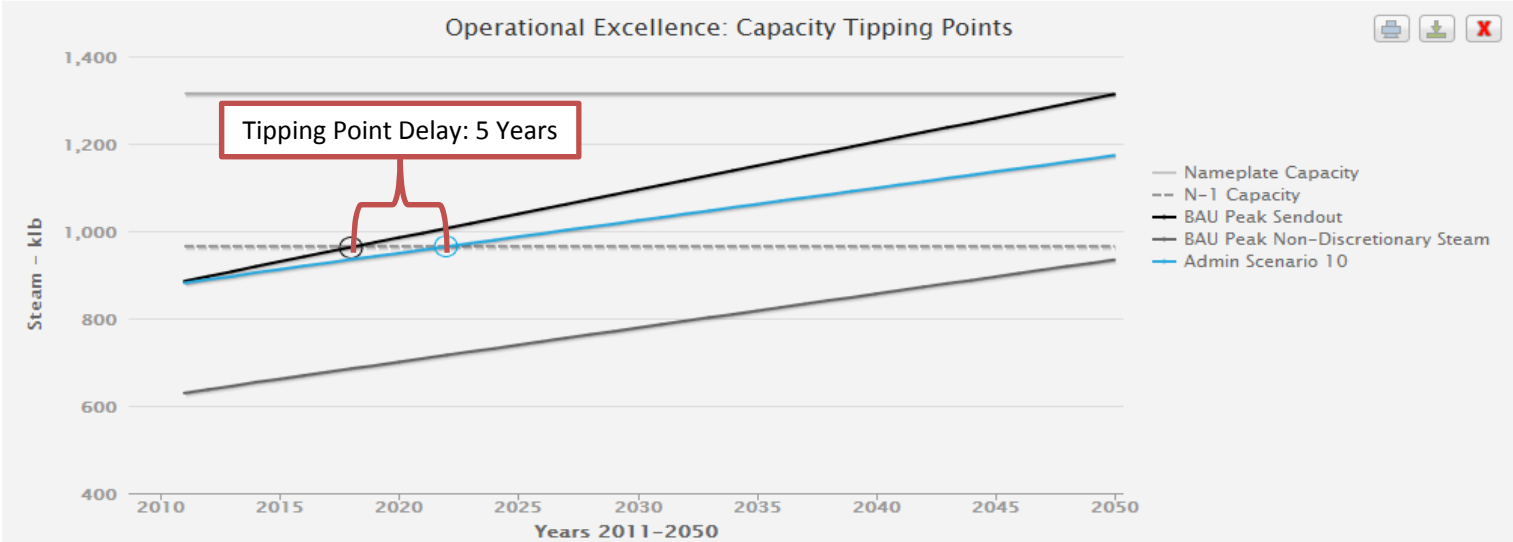

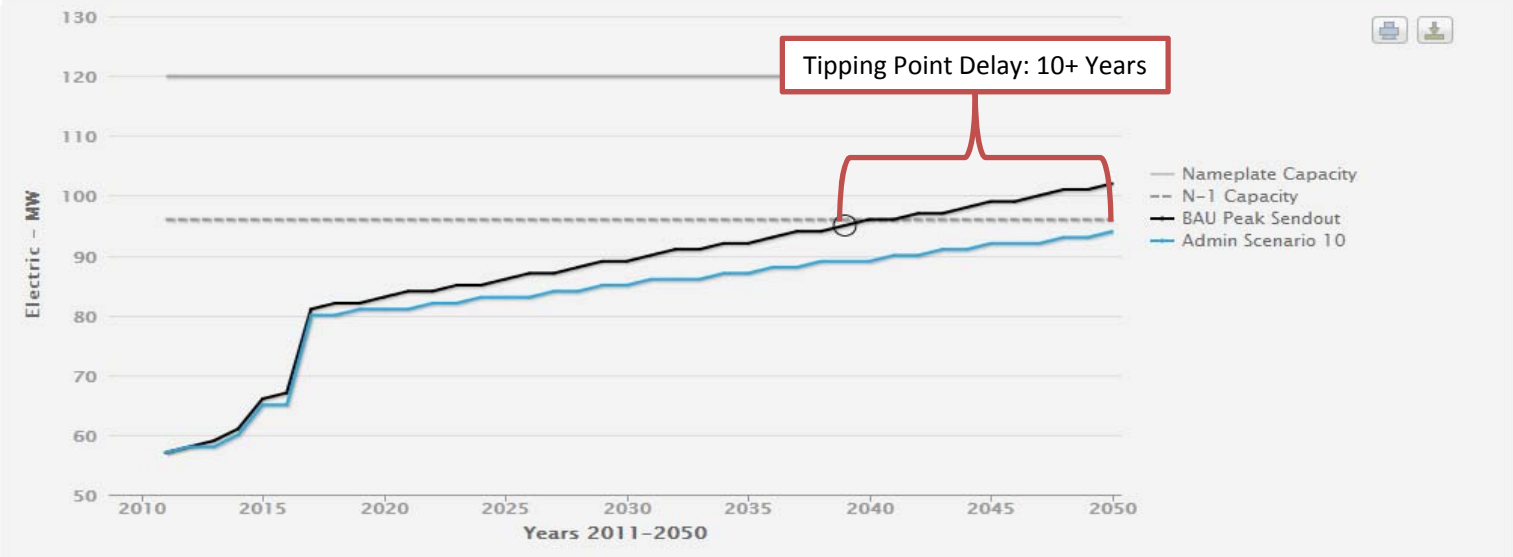

Expertise for Energy Decision Making

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- Economics and Finances – industry trends and forecasts, greenhouse gas modeling, risk analysis, obligations dictated by legislative and voluntary agreements.
- Science and Engineering – campus and building level MEP, climate policy, emerging technologies, microclimate analysis
- Campus Development – campus & capital planning, climate action planning, model agreements, peer comparisons and benchmarking, space optimization.

Stakeholders to Energy Decision Making

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With Focus on “Decision Quality”

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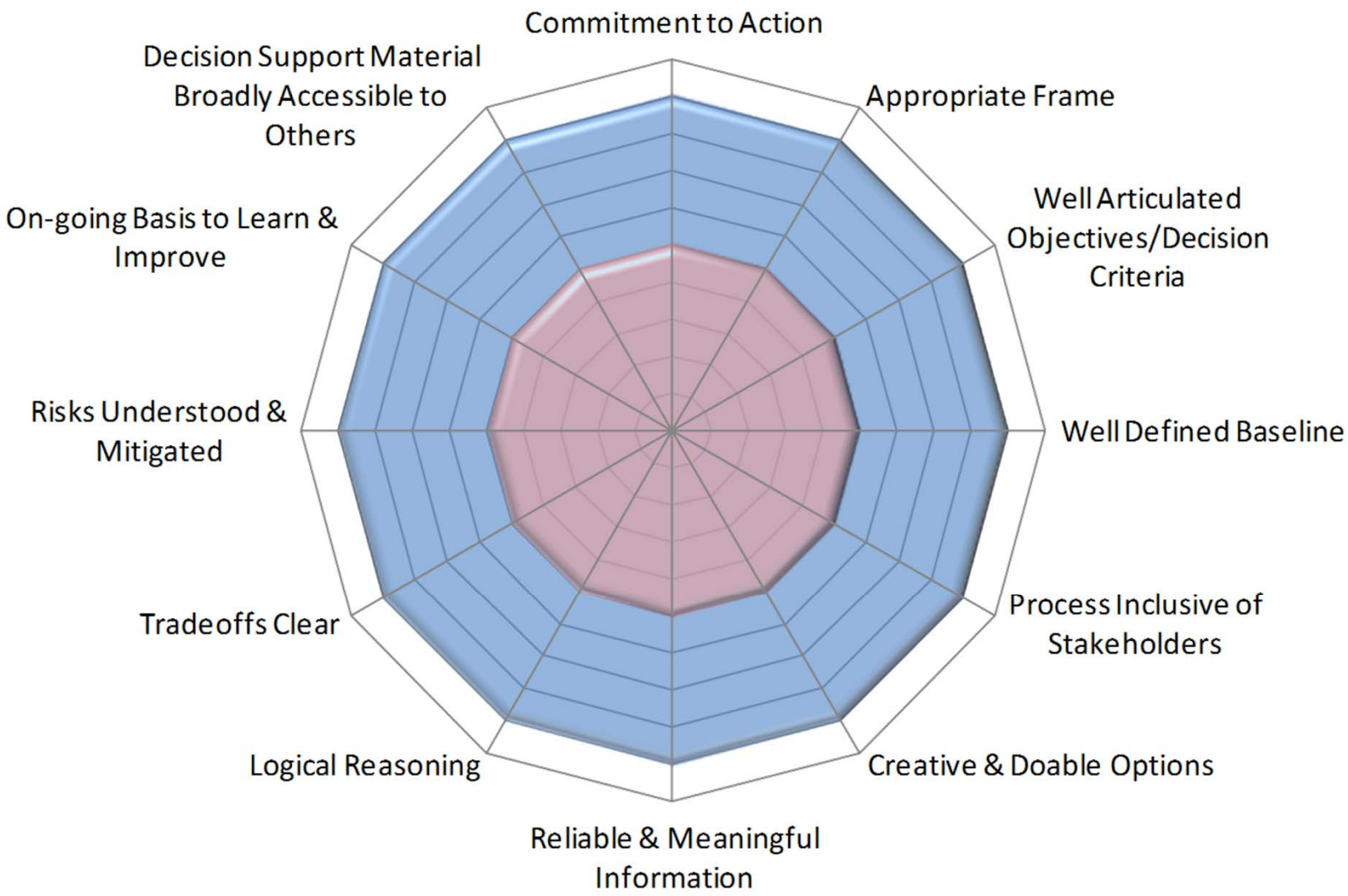

Data Complexity & Energy Decision Making

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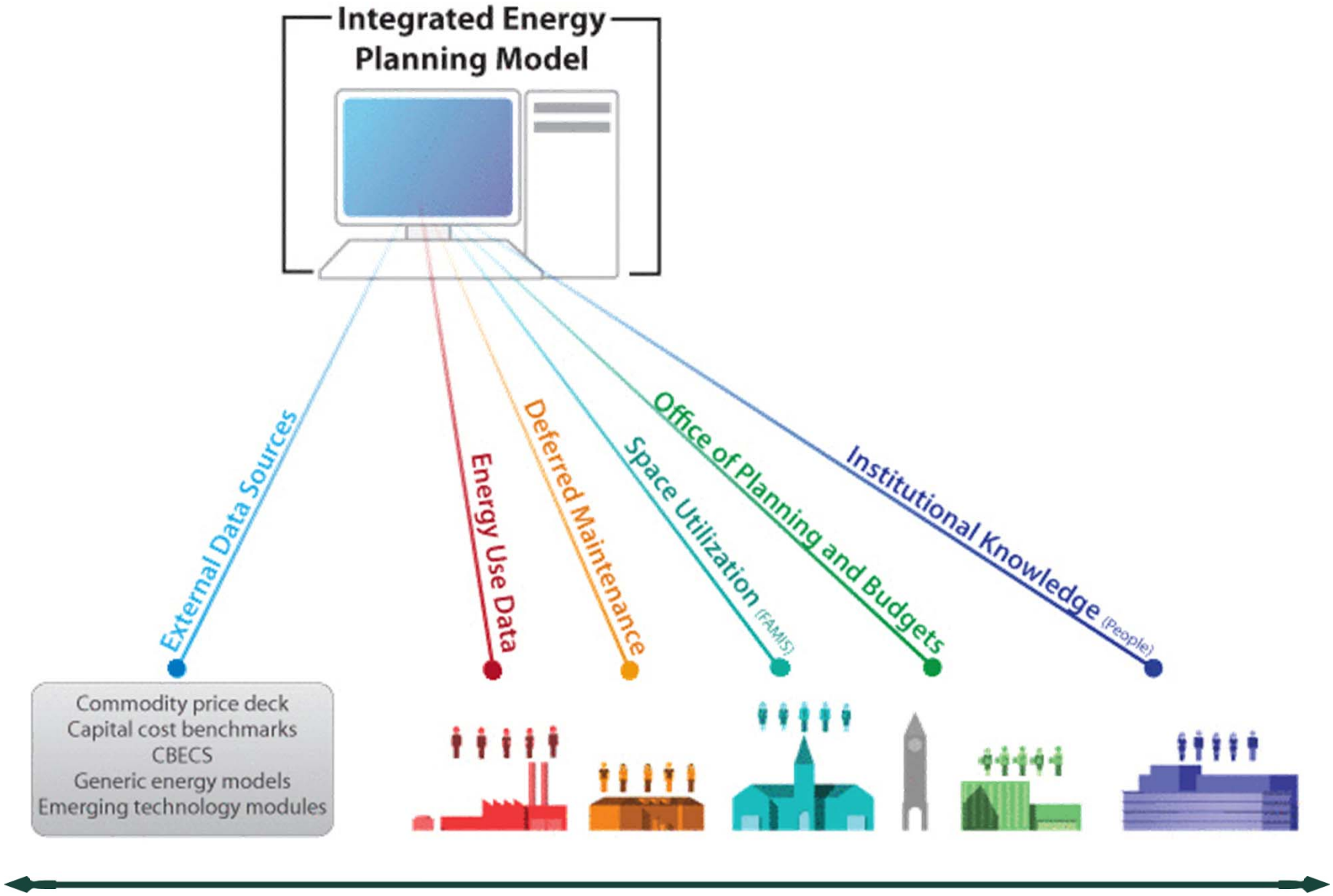

Energy Flow

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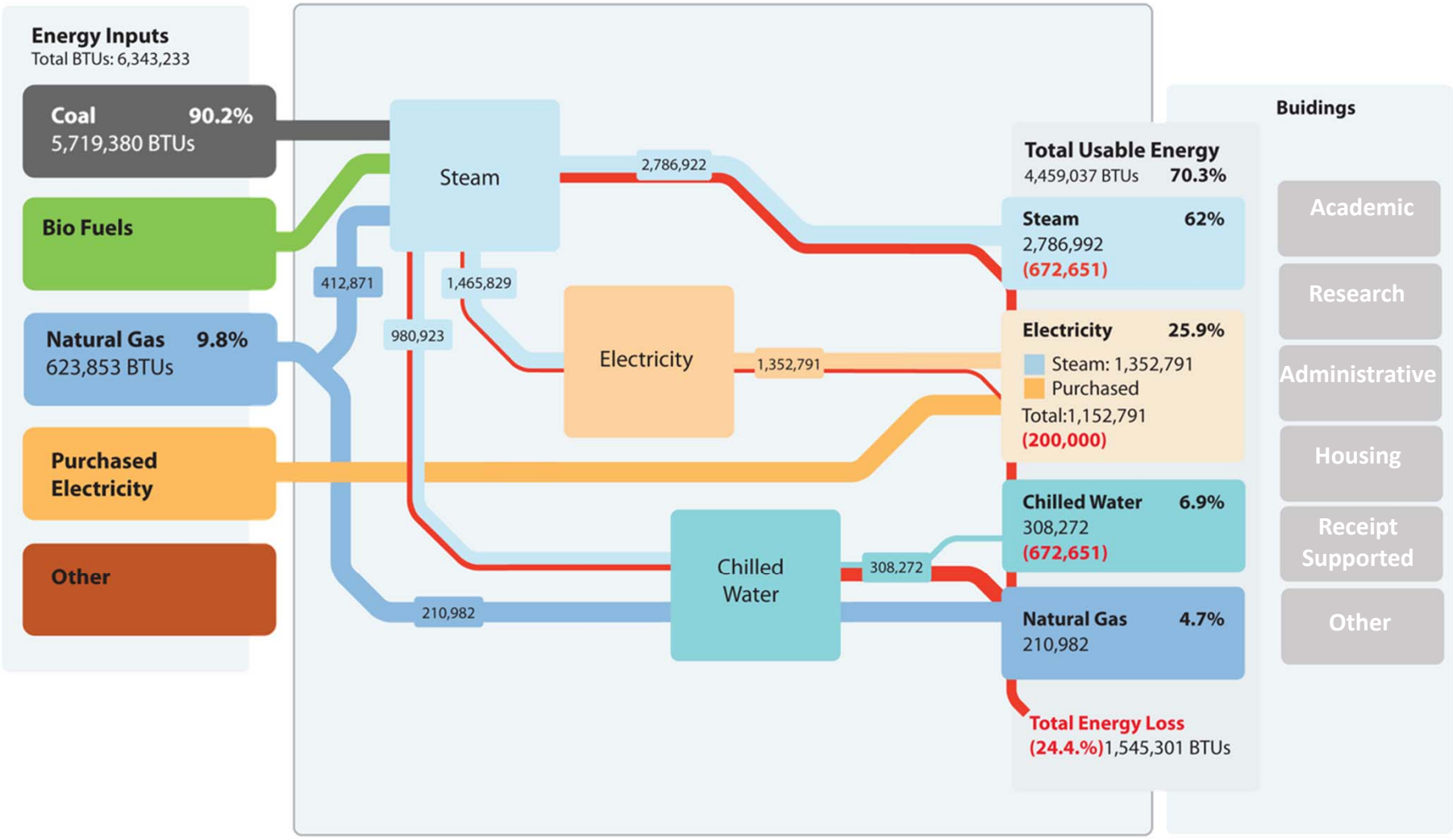

The Right Analysis for the Phase of Development

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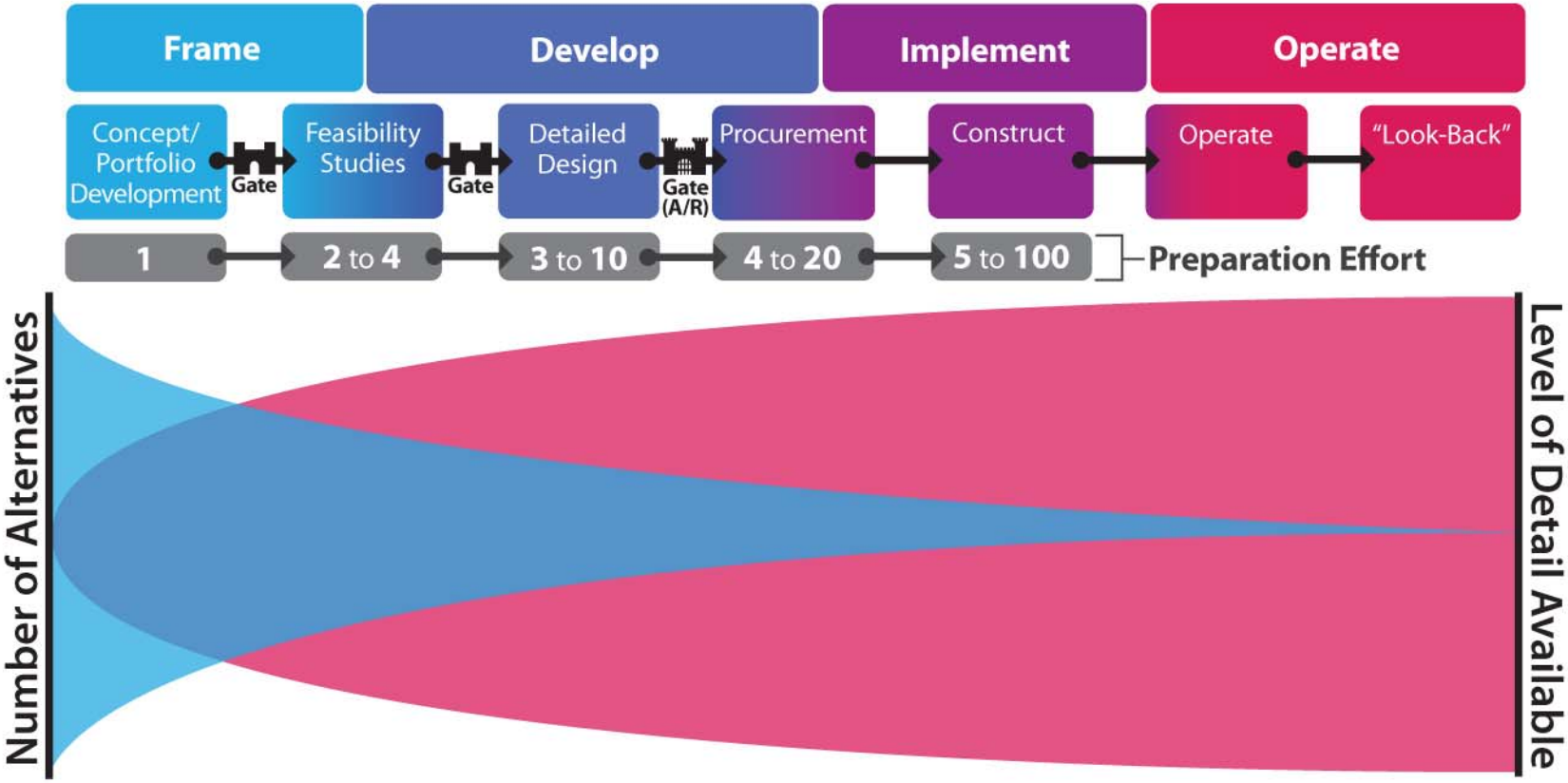

Integrated Data for Integrated Thinking

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Considers Important Risks

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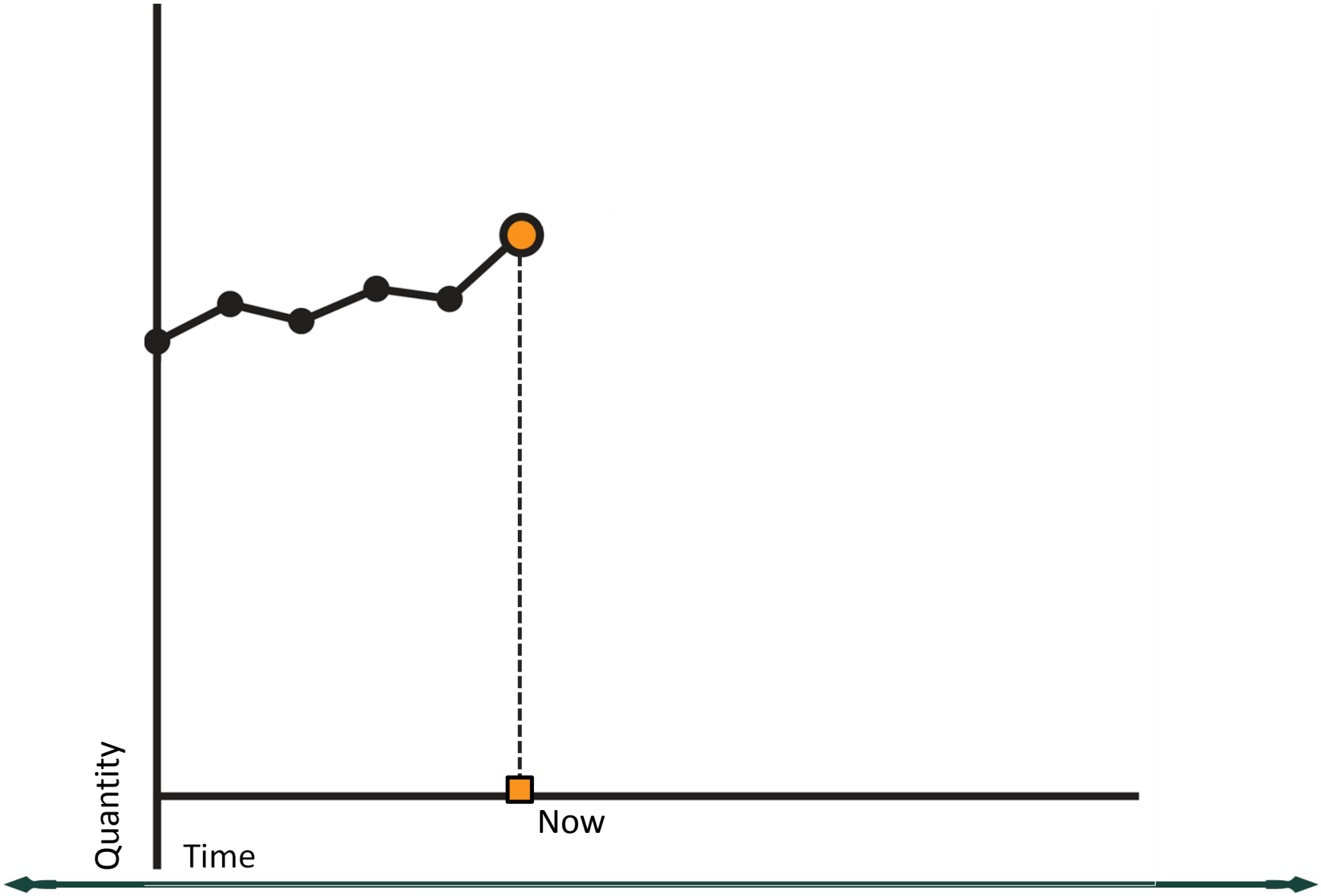
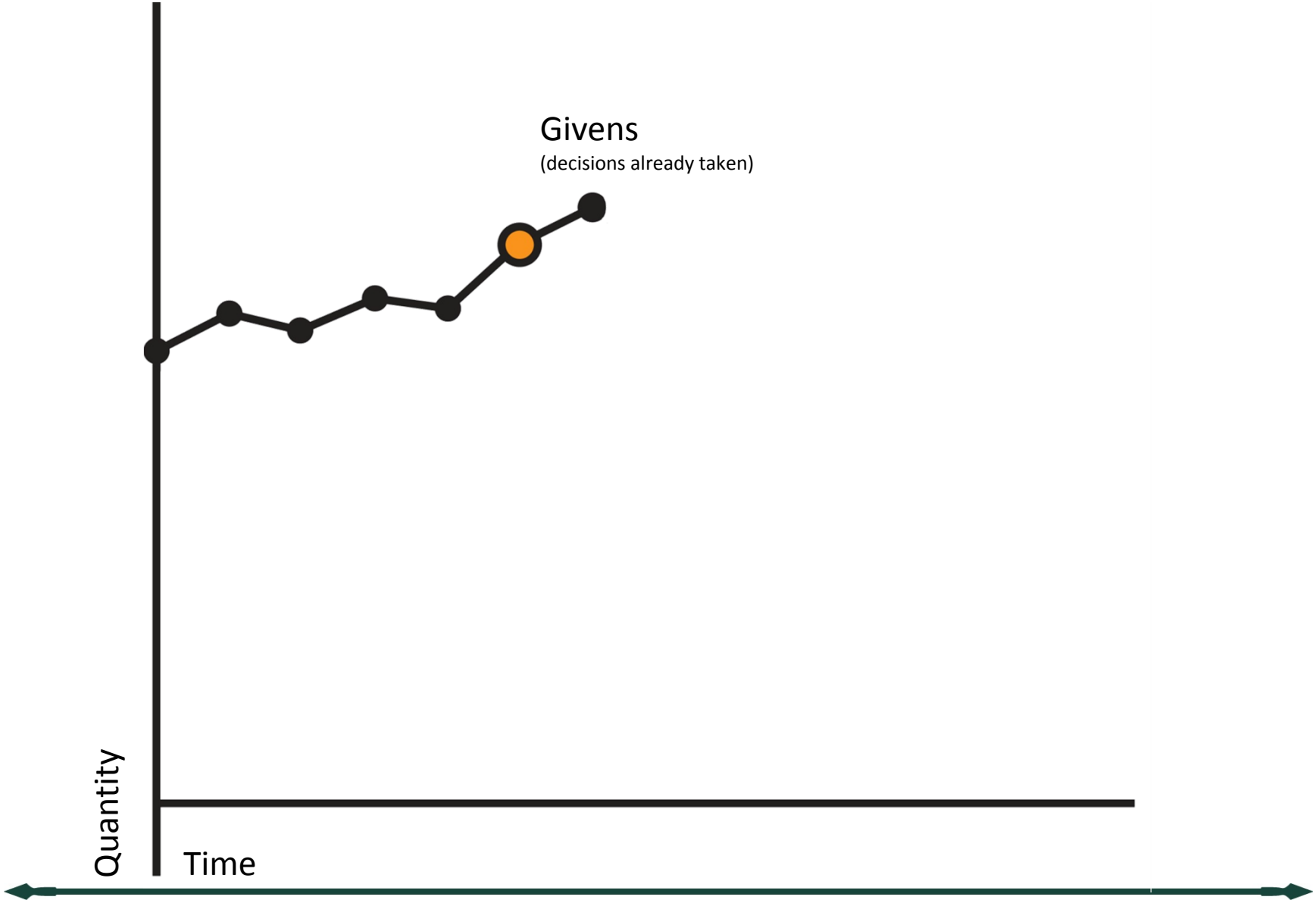
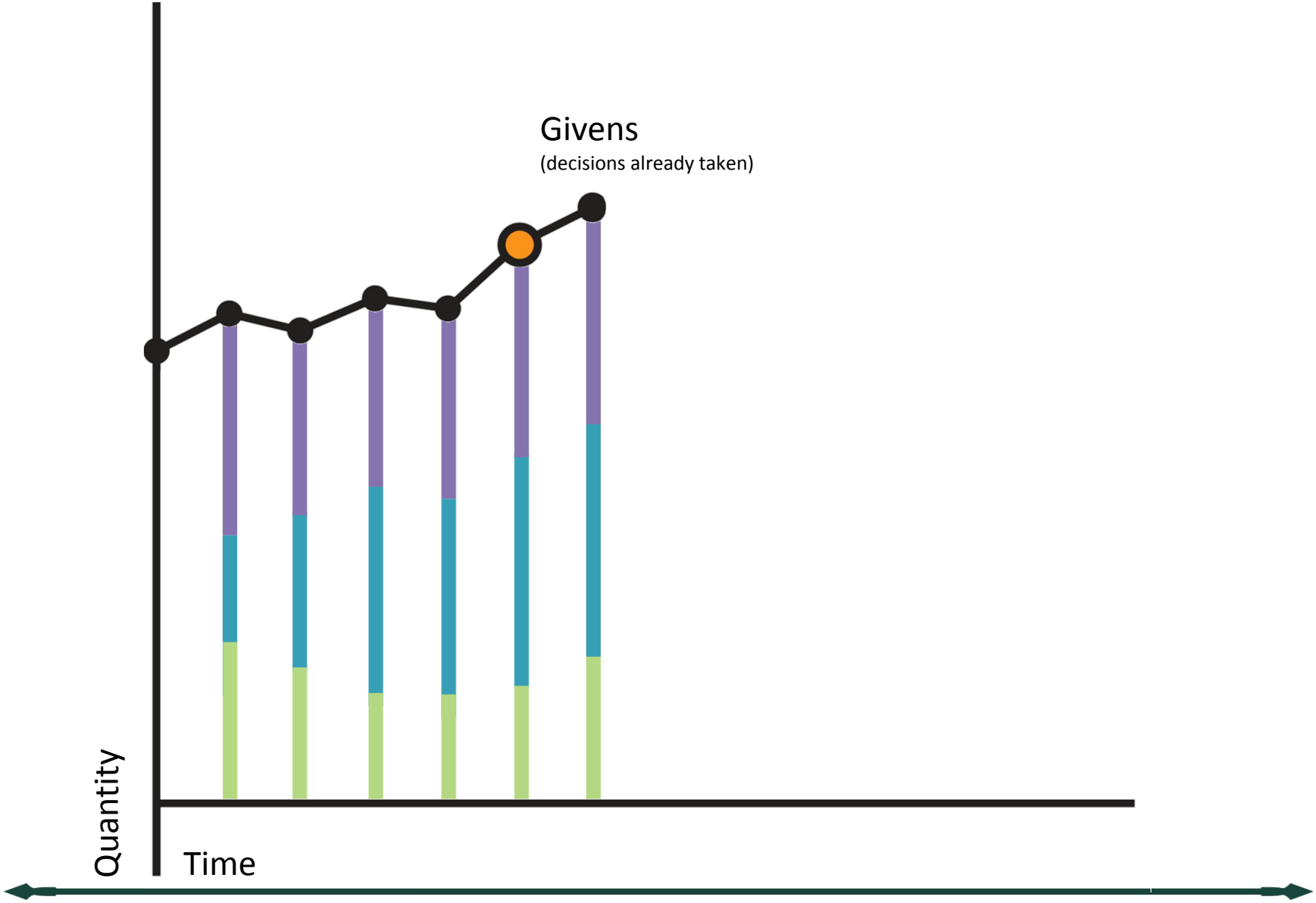
Scenario Articulation



Scenario Articulation



Scenario Articulation



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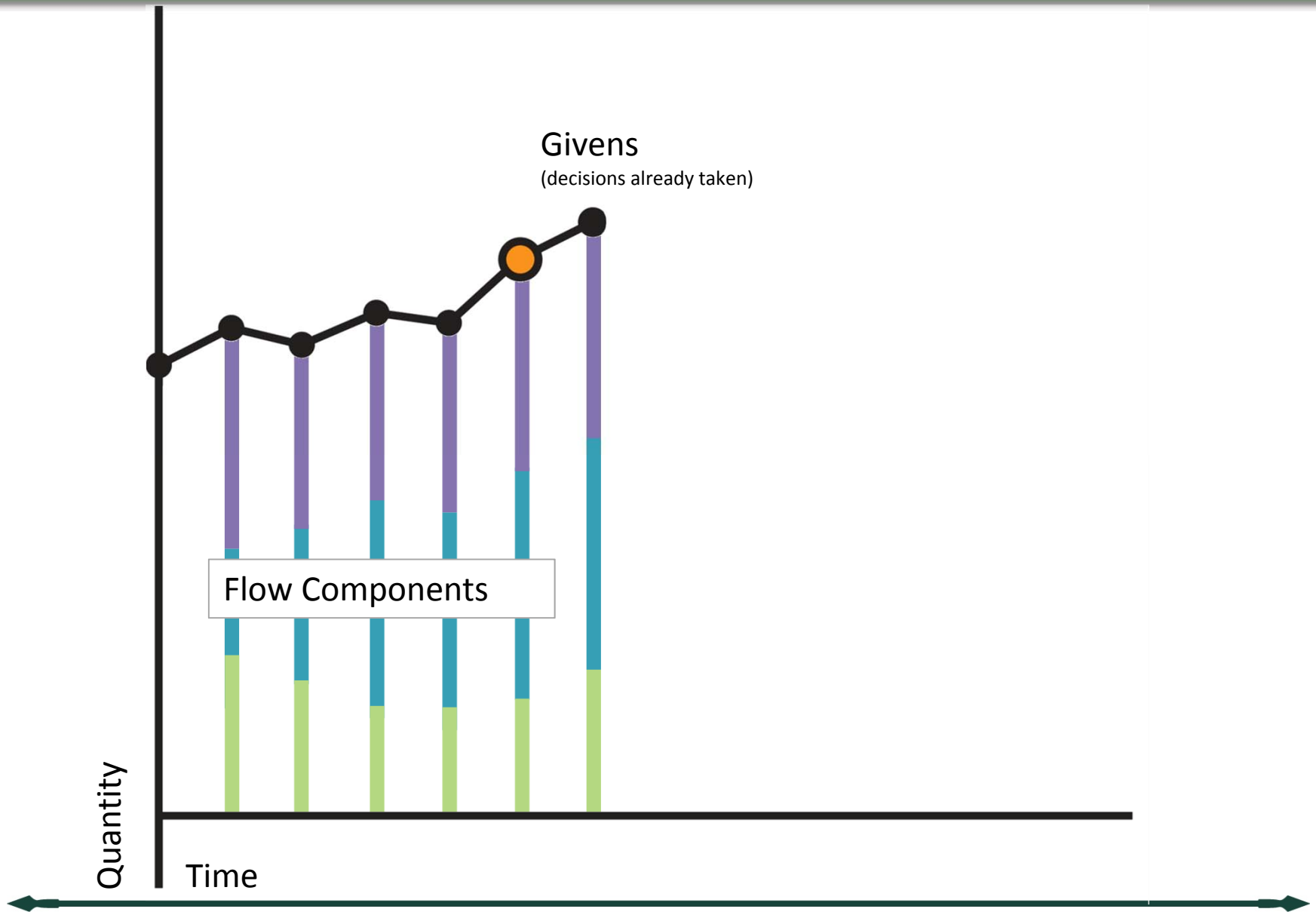
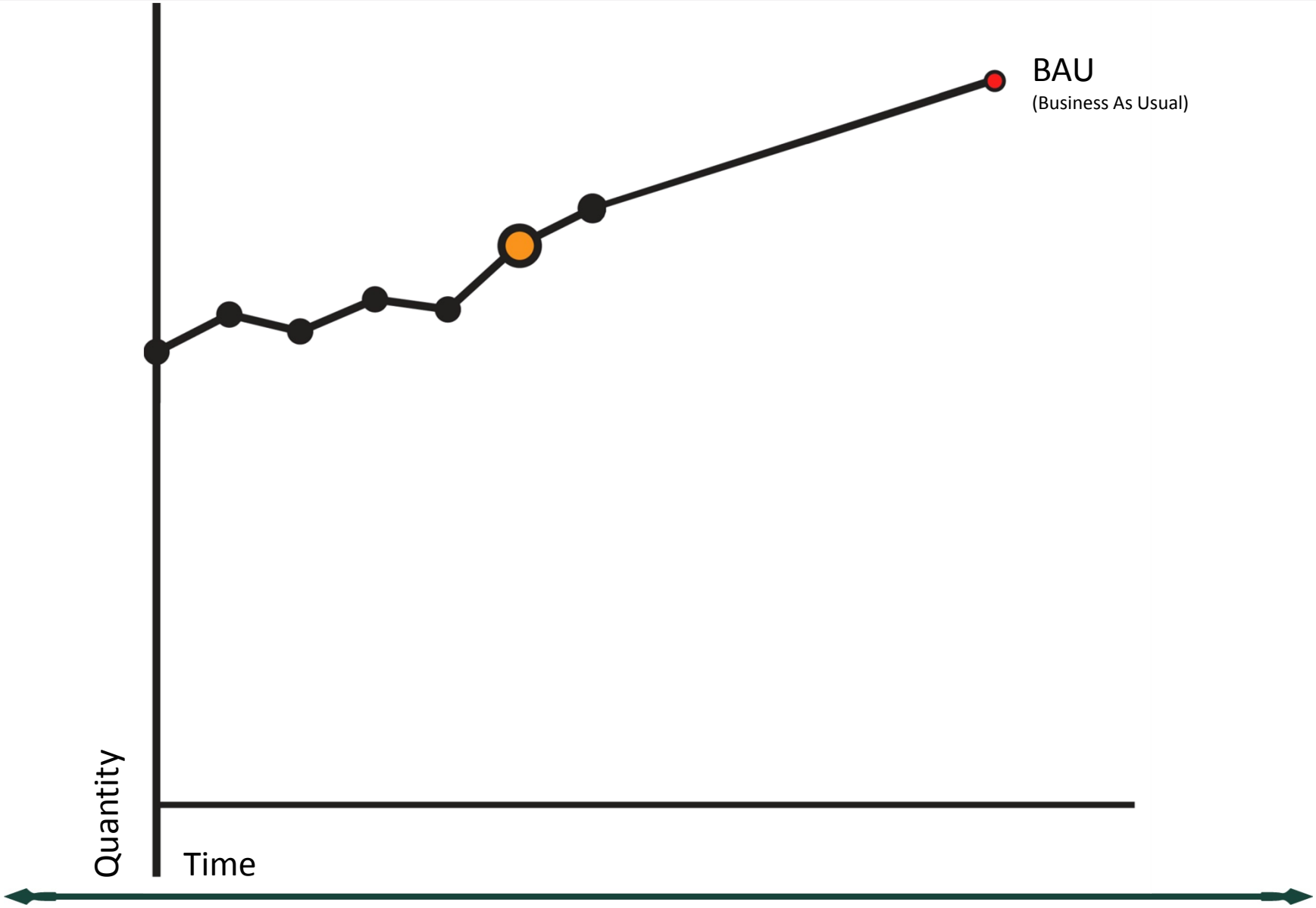


Scenario Articulation



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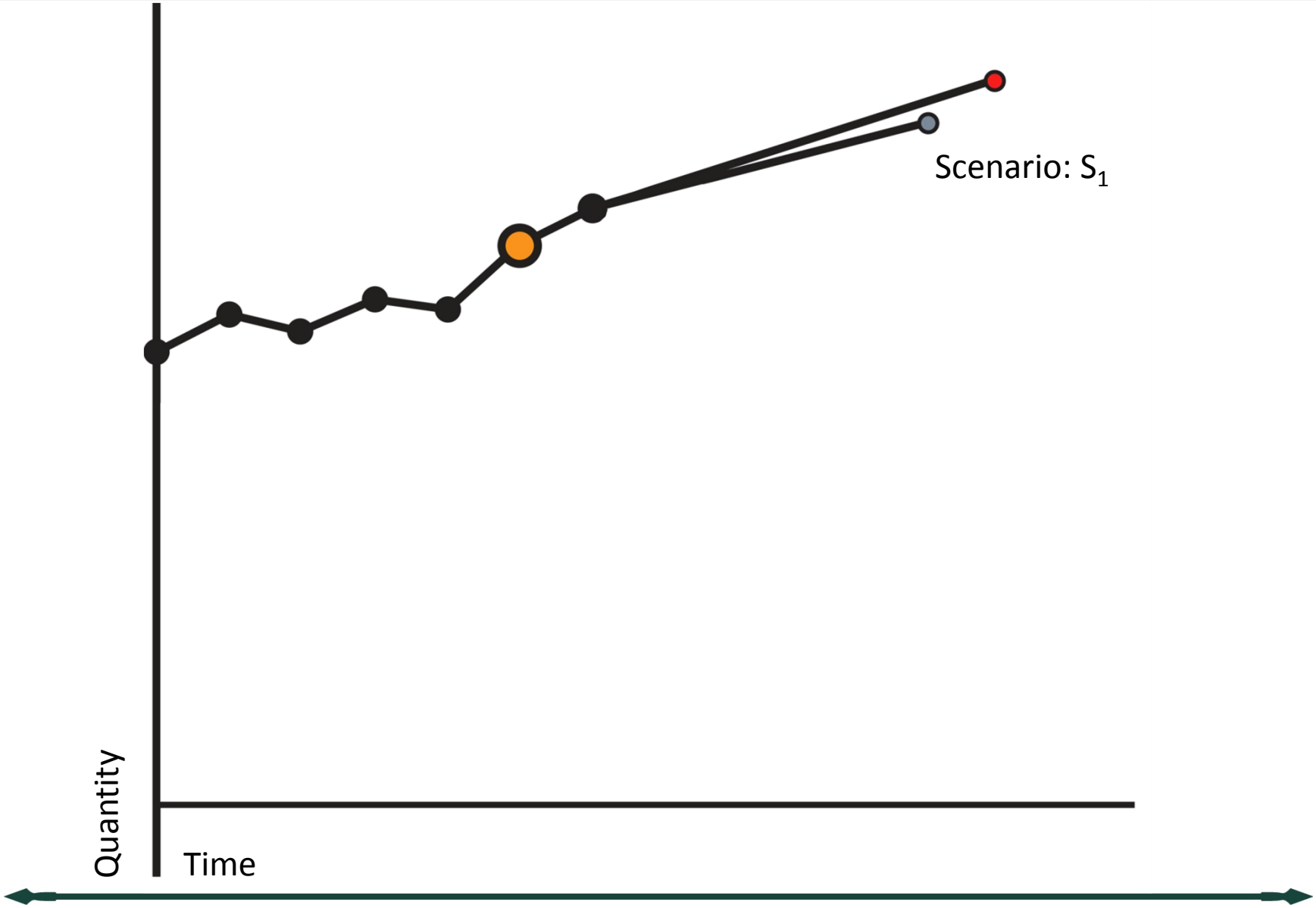
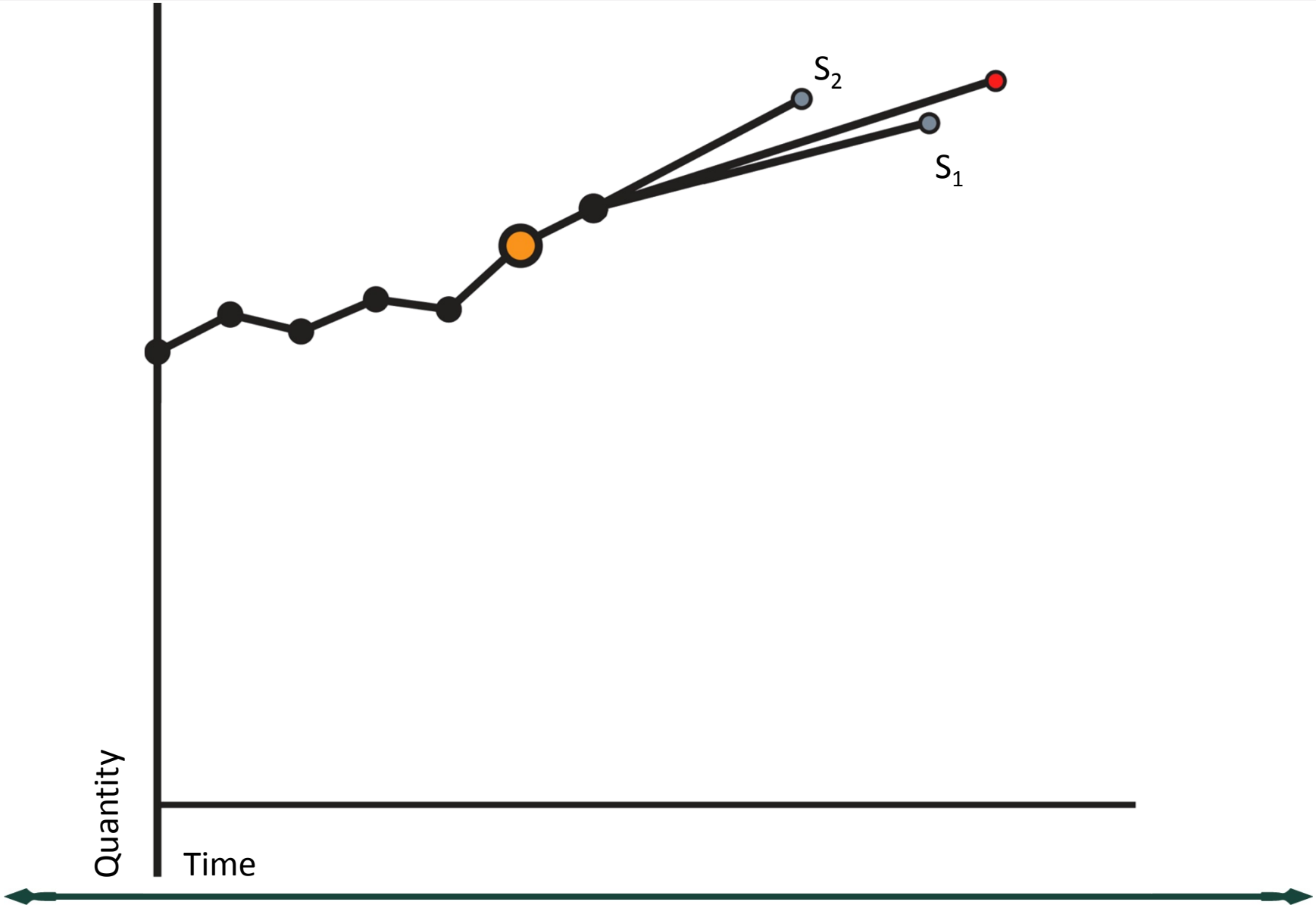
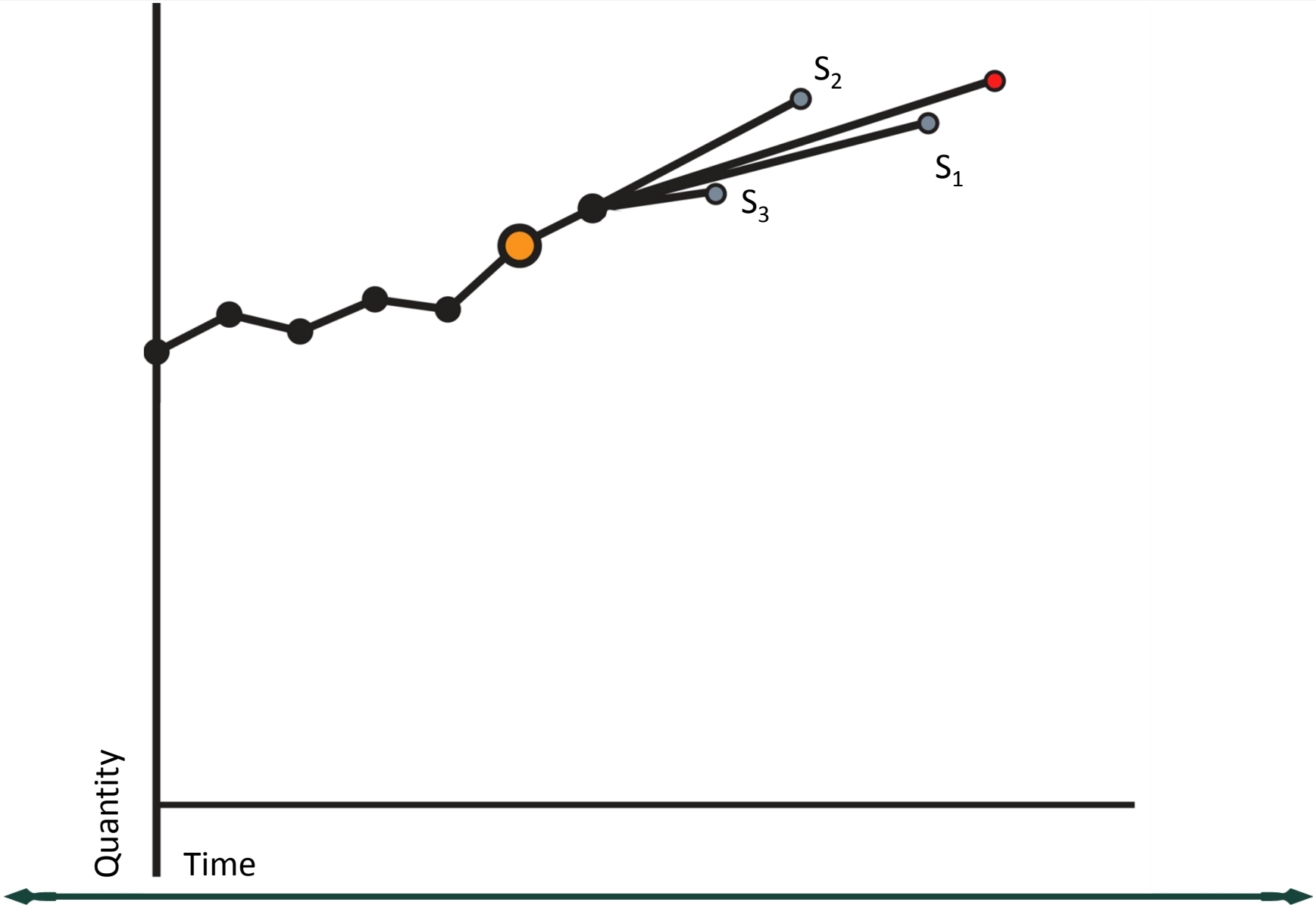


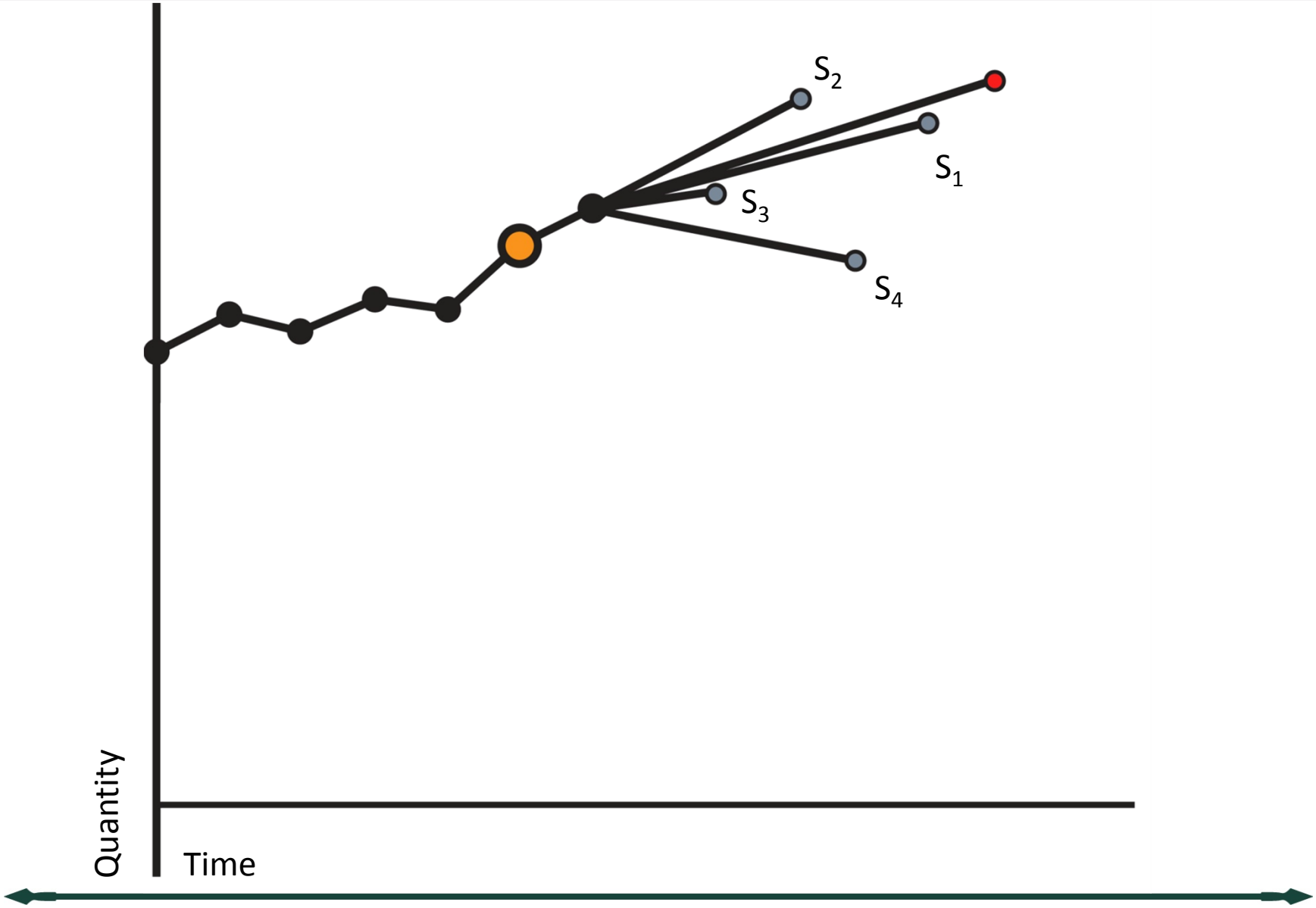
Scenario Articulation



Scenario Comparisons



Scenario Comparisons



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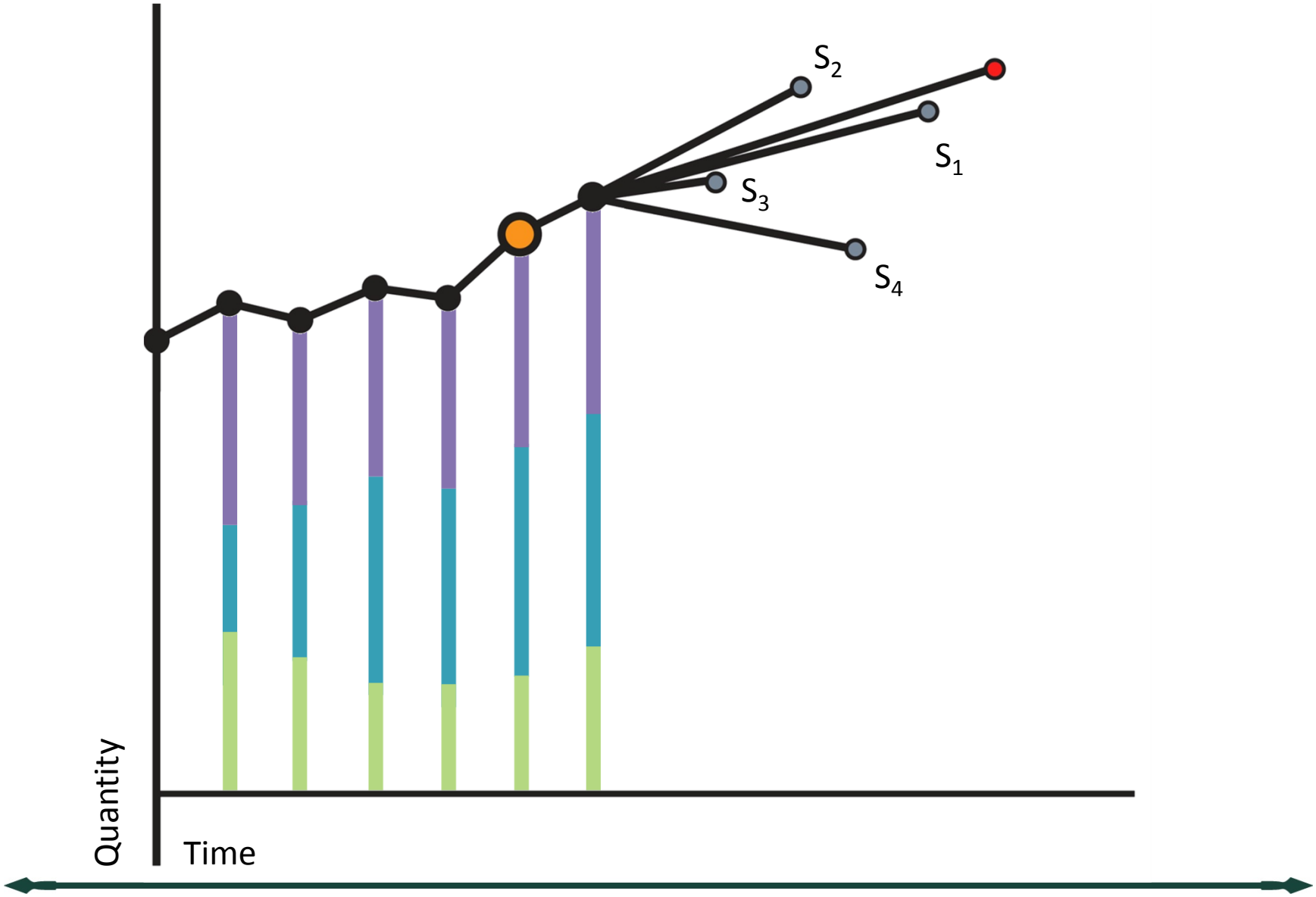
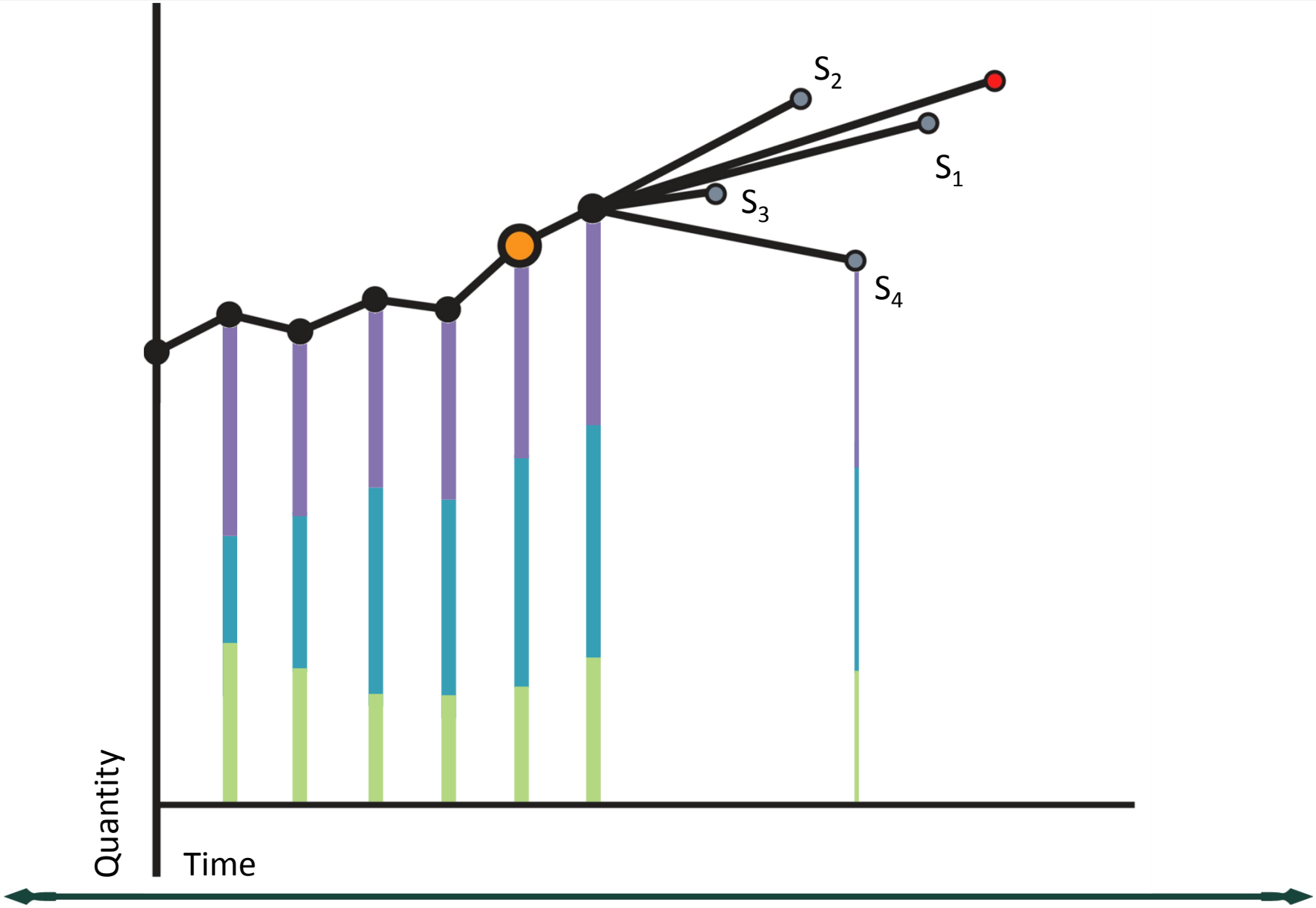
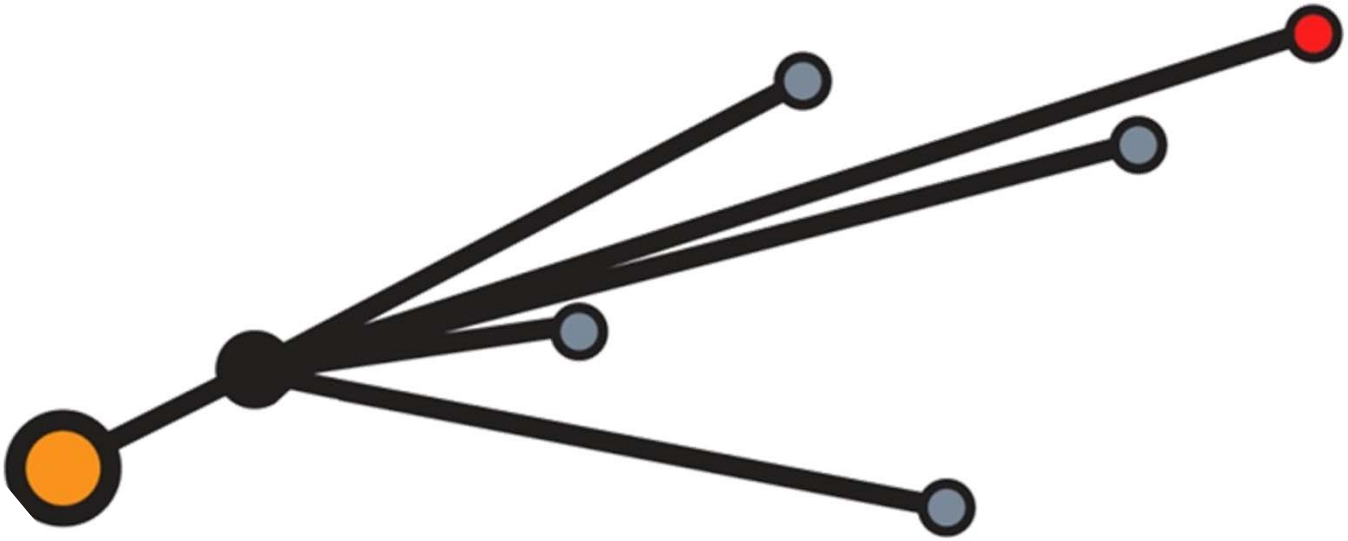


Scenario Comparisons



Scenario Comparisons



Components of MSU work

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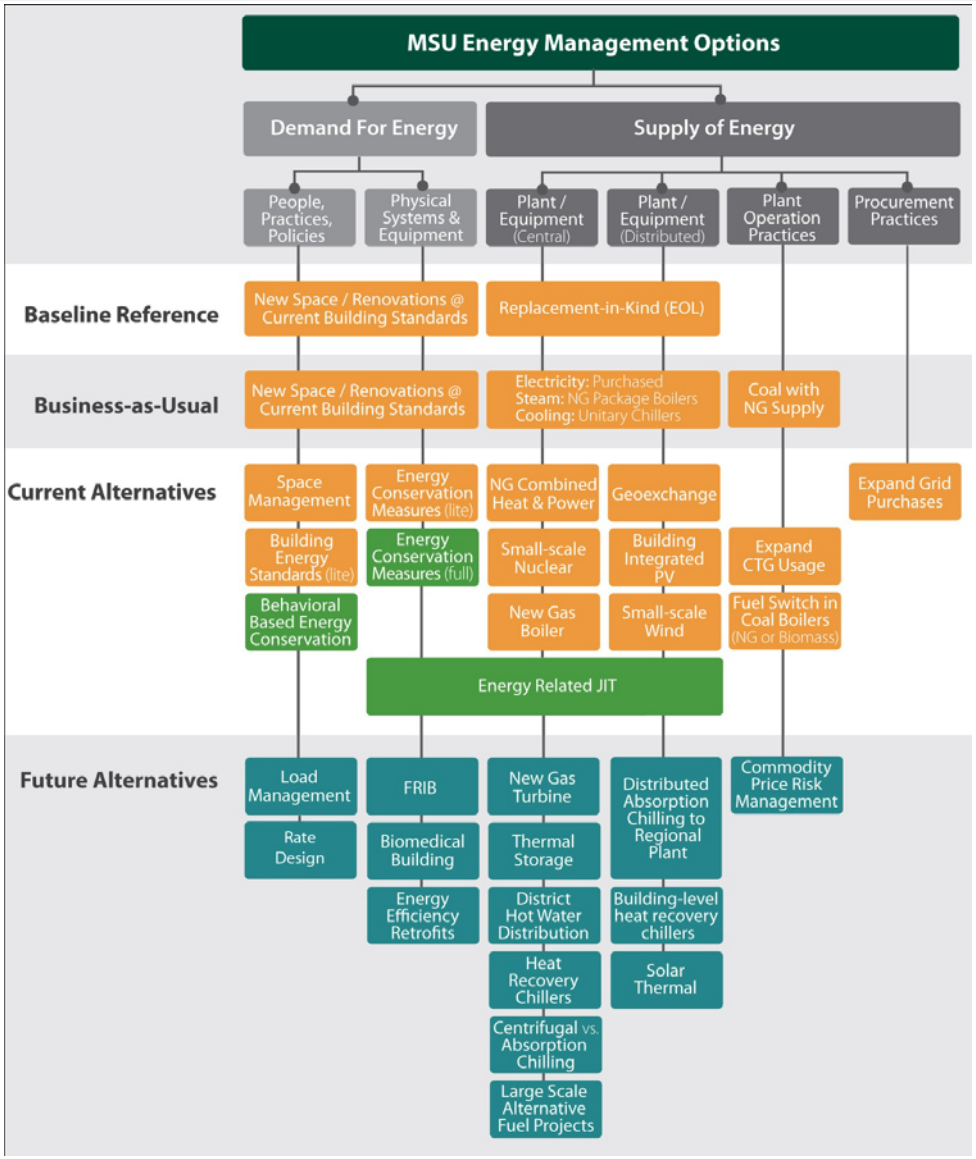

Components of MSU work

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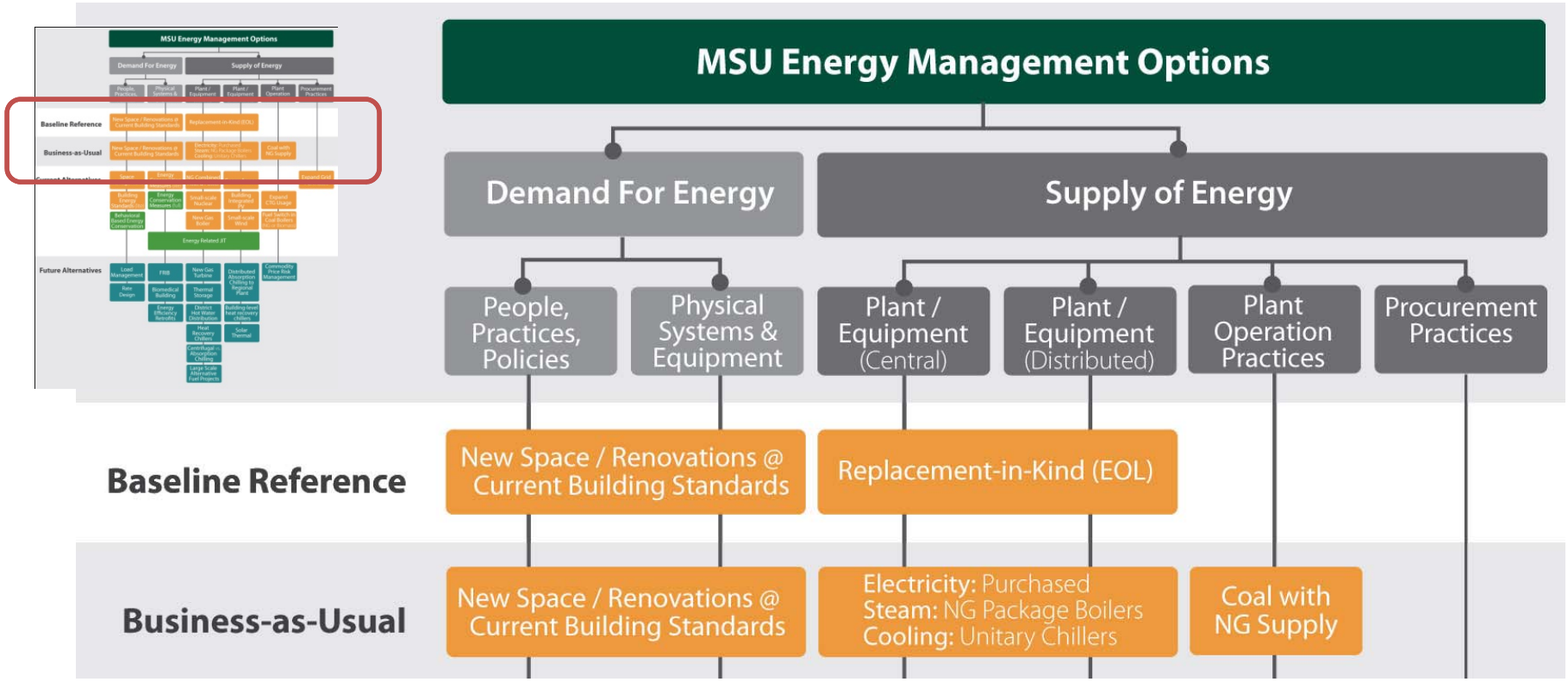

Components of MSU work

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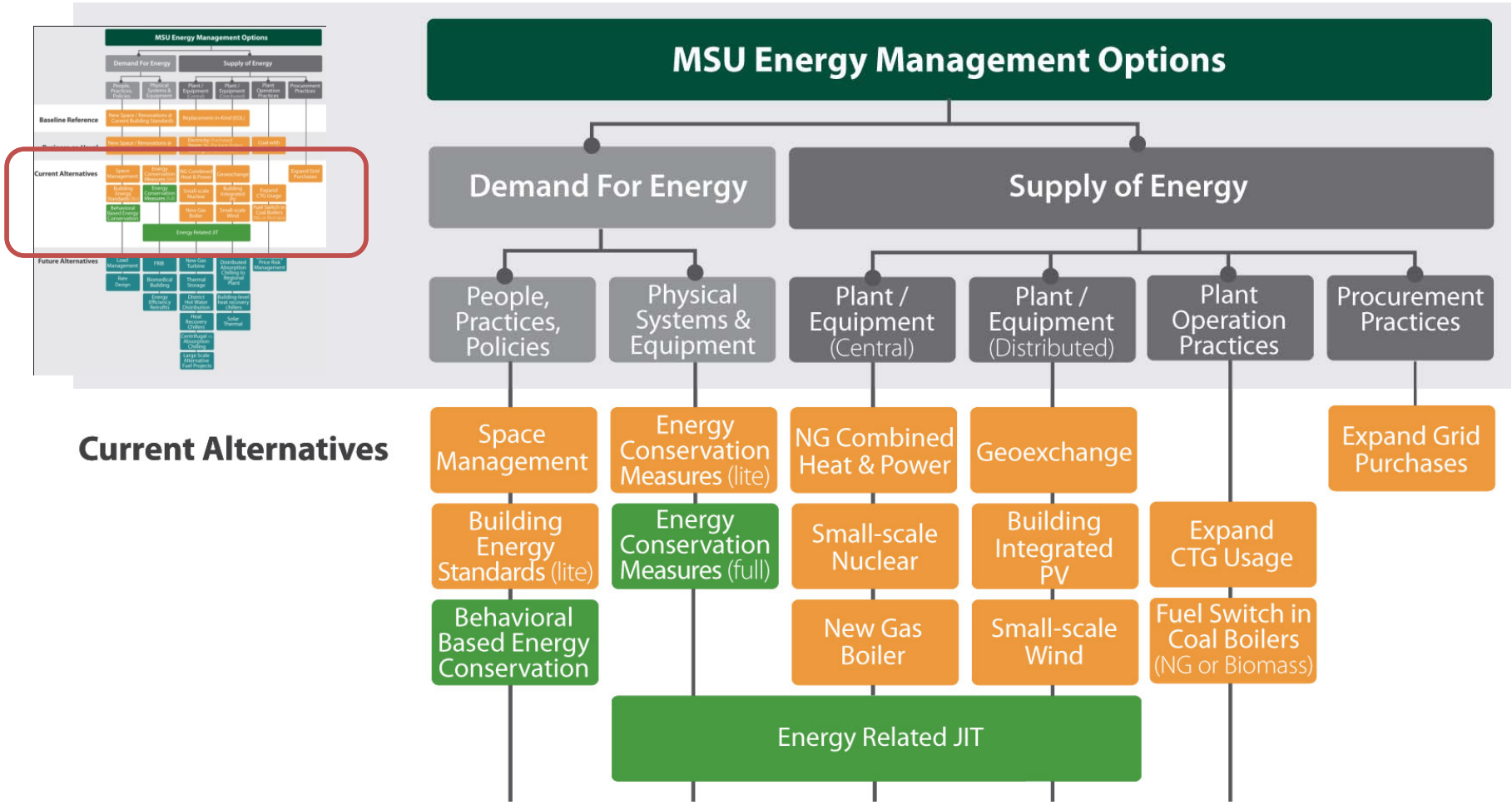

Components of MSU work

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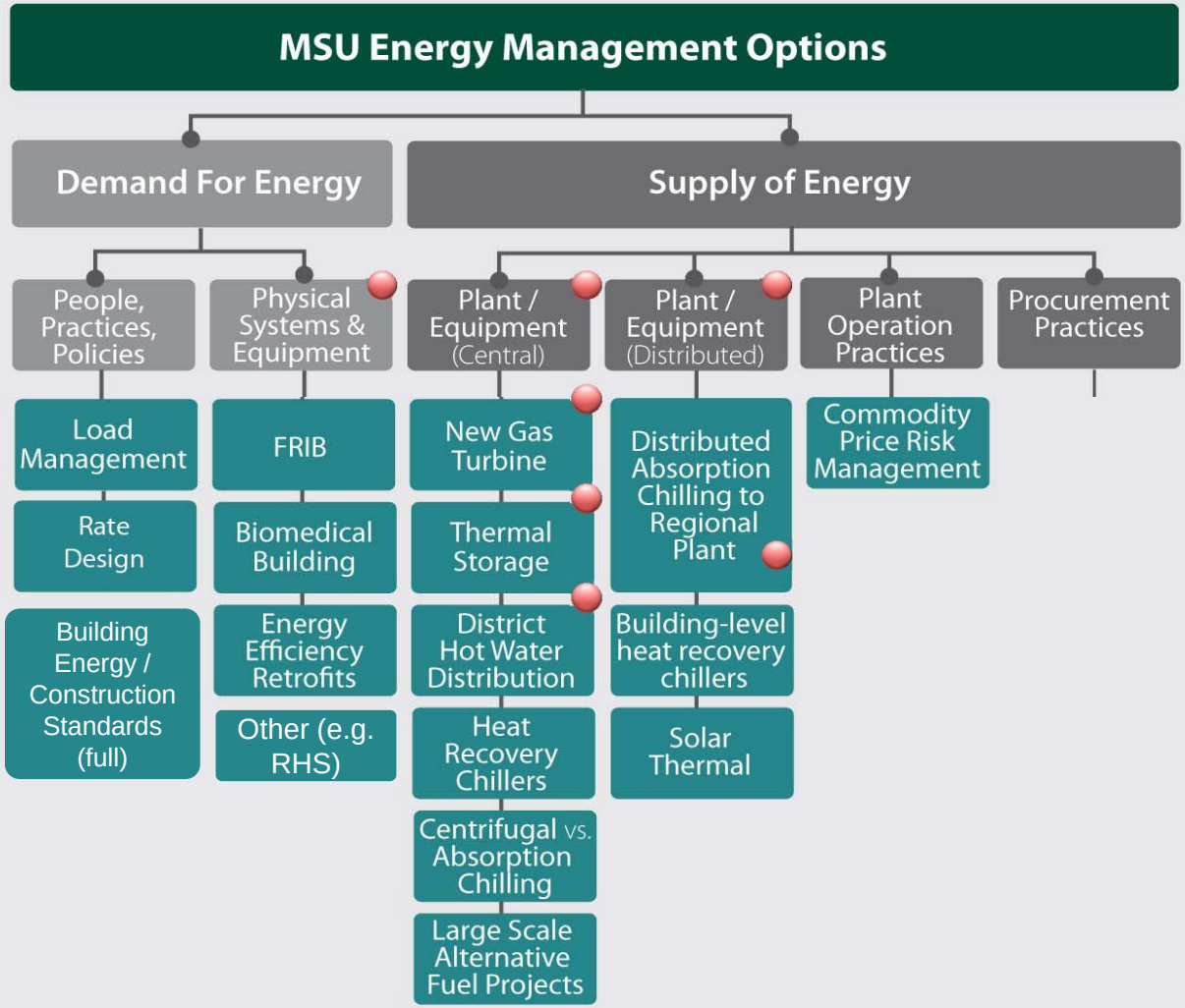
Future Alternatives



Scenario Comparison Tool

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Integrated Energy Planning Model

Model Description/Charter: The demands for energy at Michigan State University (MSU) and the manner in which those demands are served represent a complex portfolio of accumulated decisions. The purpose of this model is to provide a dynamic, integrated planning resource that is designed to allow the user to efficiently gain insights with respect to current and alternative courses of energy planning related actions. Use the navigation provided below to navigate to the desired location. On each page you will see the following "Home" button. Click this button to return to this page.

Home

Insight/Decision Modules:

- Integrated Energy Management Portfolio Planning
- Confirm Baseline Reference Case
- Establish External Planning Environment
- Energy Management Planning Demand Related
- Energy Management Planning Supply Related
- Documentation & Other Resources

Scenario Comparison Tool

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MSU ENERGY STRATEGIES CREATE UPLOAD COMPARE rmckenna@energystrat.com | Logout

ADD SCENARIO(S) Admin Scenario 1 Admin Scenario 3 Admin Scenario 5

Model ver 5.0 **Business As Usual**	Scenario **Admin Scenario 1**	Scenario **Admin Scenario 3**	Scenario **Admin Scenario 5**
Key Metrics:	Key Metrics:	Key Metrics:	Key Metrics:
FISCAL STEWARDSHIP	FISCAL STEWARDSHIP	FISCAL STEWARDSHIP	FISCAL STEWARDSHIP
Cost of Utility Service	Cost of Utility Service	Cost of Utility Service	Cost of Utility Service
Required Capital	Required Capital	Required Capital	Required Capital
Impact on Tuition	Impact on Tuition	Impact on Tuition	Impact on Tuition
OPERATIONAL EXCELLENCE	OPERATIONAL EXCELLENCE	OPERATIONAL EXCELLENCE	OPERATIONAL EXCELLENCE
Capacity Tipping Points	Capacity Tipping Points	Capacity Tipping Points	Capacity Tipping Points
Overall Plant Efficiency	Overall Plant Efficiency	Overall Plant Efficiency	Overall Plant Efficiency
ENVIRON./HEALTH STEWARDSHIP	ENVIRON./HEALTH STEWARDSHIP	ENVIRON./HEALTH STEWARDSHIP	ENVIRON./HEALTH STEWARDSHIP
% Reliance on Coal	% Reliance on Coal	% Reliance on Coal	% Reliance on Coal
GHG Emissions	GHG Emissions	GHG Emissions	GHG Emissions
Description: This version of the model includes some minor updates to calculations and assumptions throughout the model plus the inclusion of 5 new supply related options: Small Scale Nuclear, Boiler 3 MACT Compliance - New Gas Cogen, Boiler 3 MACT Compliance - New Gas Boiler, Building Integrated Solar PV, On-site, Small-scale Wind. This version also includes consideration of the impact on tuition and debt capacity.	Primary Objective: Delay Capacity Tipping Points Options Used: Building Energy Standards How the demand and supply options were applied: Implemented a building energy standard that requires renovations to use 10% less energy per GSF than current space and requires new space to use 20% less energy than current space.	Primary Objective: Delay Capacity Tipping Points Options Used: Expand Gird Purchase (Reduce Condensing) How the demand and supply options were applied: Expand grid purchases with a "peak following" strategy to reduce the peak steam requirements imposed upon the central plant	Primary Objective: Reduce Reliance on Coal Options Used: Expand NG Use in Coal Boilers How the demand and supply options were applied: Fuel switch to the maximum amount possible in all coal boilers in 2014.
Download Model v5.0	Download Scenario	Download Scenario	Download Scenario

Access to the Model

- Register name and MSU e-mail (netID)
- Each student will receive an e-mail which contains:
  - Username
  - Password
  - Link
- Each student will complete the Non-Disclosure Agreement and get access to the model and scenario comparison tool.
- Bill will be available for continuing questions and support
  - wjlakos@ipf.msu.edu

Integrated Energy Decision Making

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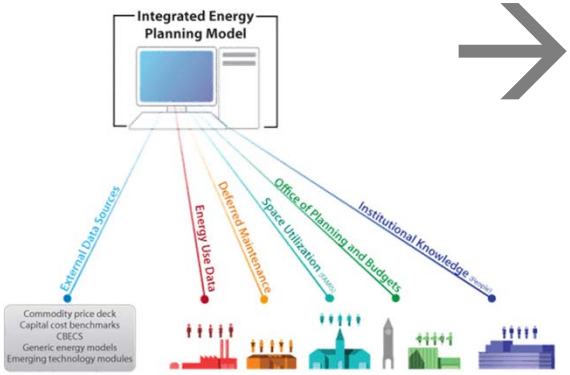

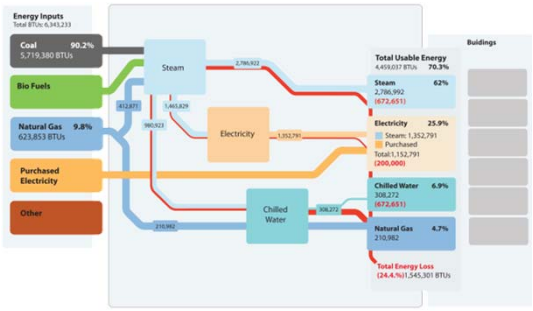

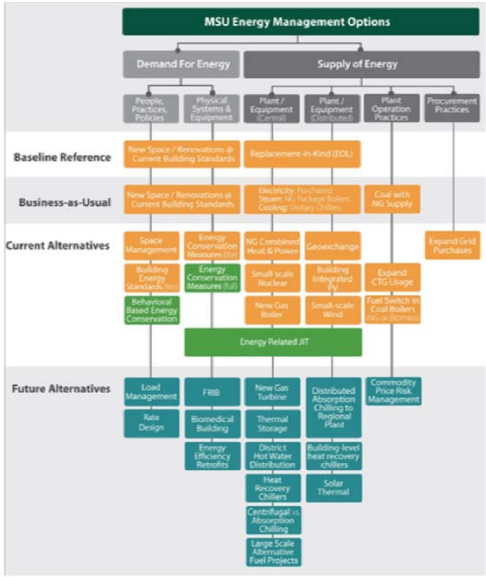

Integrated Energy Decision Making

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Integrated Energy Planning Model (IEPM)

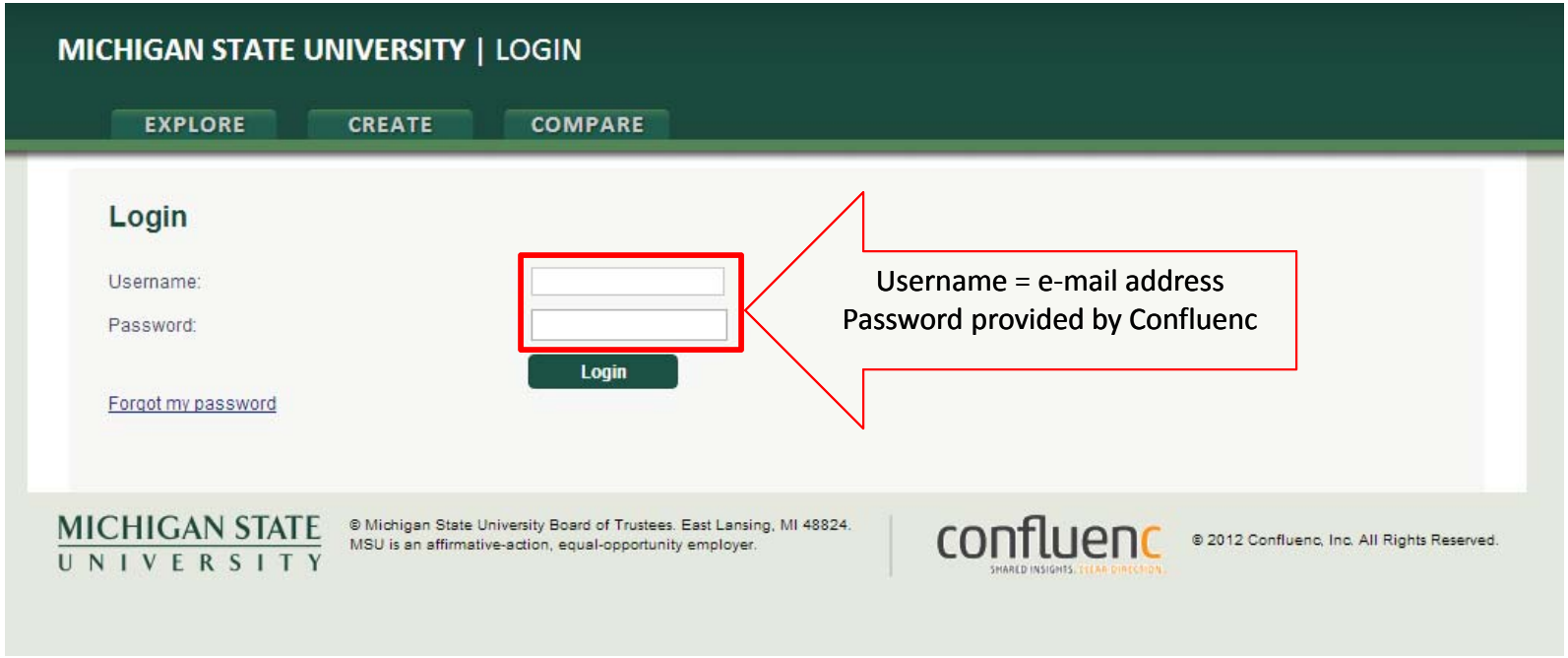
- Hosted by Confluenc
- Secure web access
- http://msuiepm.confluenc.com
- Built using Microsoft Excel

Explore
- Building Profiles
- Browse Buildings
- Search Buildings
- Energy Conservation Measures (ECM)

Create
- ECM Portfolios
- Campus Scenarios

Compare
- ECM Portfolio
- Campus Scenario

Launch Web-Site & Login



MICHIGAN STATE UNIVERSITY | Energy Planning Environment

Welcome, wjlakos@pplant.msu.edu

EXPLORE CREATE COMPARE MANAGE

Energy Planning Environment

The Energy Planning Environment has been developed to support strategic planning and decision making by Michigan State University administrators as they seek to optimize campus operations, prioritize capital expenditures and assess options for energy transition and sustainability. To report any issues or receive support in using this environment please contact Confluenc, Inc.

Explore

Review information relating to university buildings by exploring "Building Profiles" — a collection of details for each building including space breakdown, energy consumption, Just-in-Time projects, Survey data (descriptions of each major building system), and Energy Conservation Measures (ECMs).

Buildings can also be reviewed from the perspective of energy conservation measures through filtering the entire building list by applicable ECM(s). A description of each ECM, including key assumptions, is also available.

Create

Develop material for consideration in planning efforts. Follow the links here to create:

- Energy conservation portfolios: collections of energy conservation measures by building, type of measure, payback period and more.
- Campus Scenarios: Define a campus energy scenario, save the file to your computer and create one or many energy portfolio scenarios to be able to compare your scenarios to those created and shared by others.
- Building Surveys: Input or refine building-specific information for various energy-related systems on campus facilities.

Compare

Once you have created a new Campus Scenario comparison to the Business-as-Usual case, other reference cases, and all other existing Campus Scenarios is possible. Additionally, Energy Conservation Portfolios can be compared to one another to determine a preferred portfolio for inclusion in a Campus Scenario or for possible implementation.

Gain insights into the opportunities and trade-offs available to the University by considering a variety of scenarios and portfolios.

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confluenc SHARED INSIGHTS. CLEAR DIRECTION.

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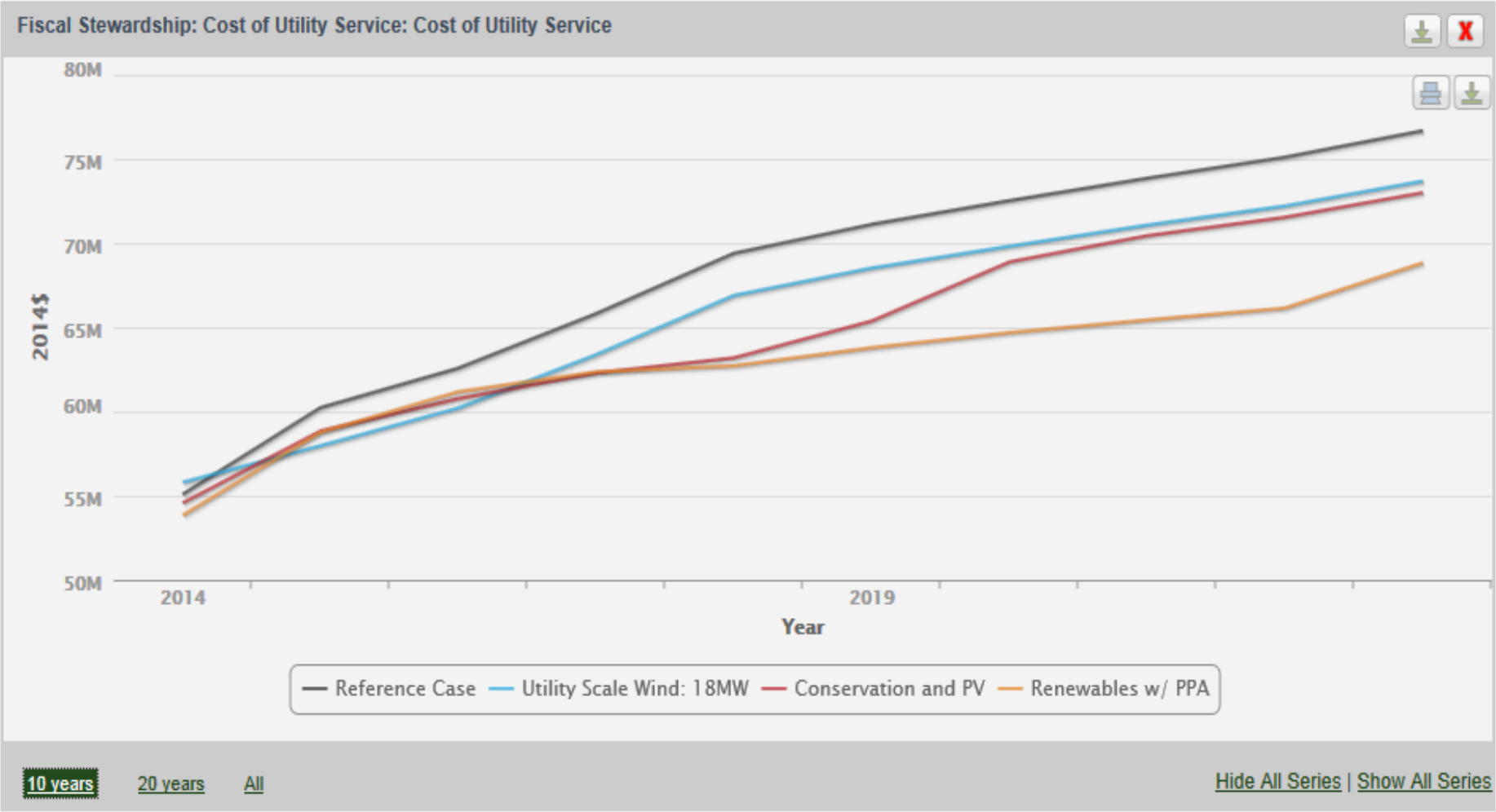
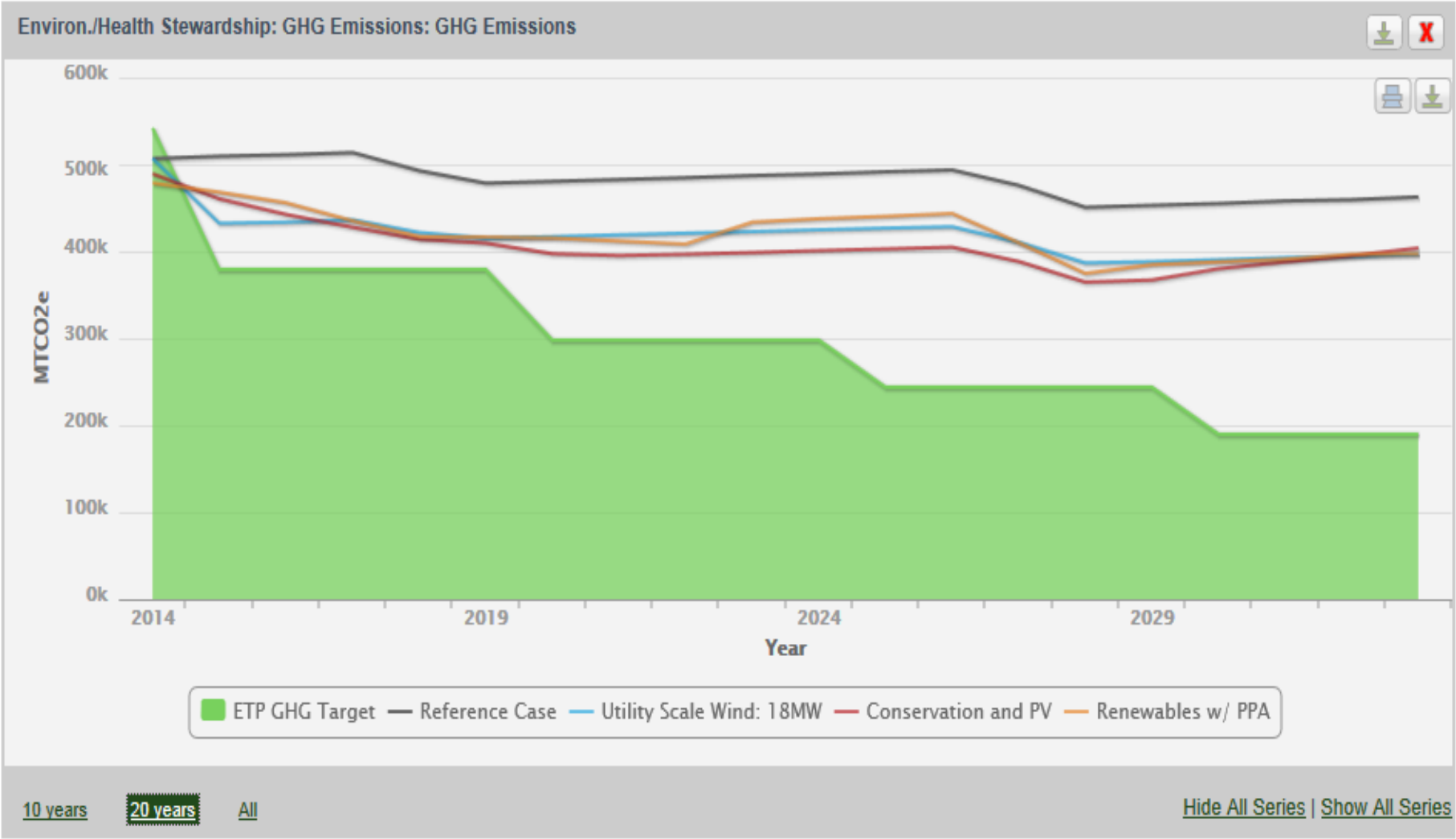
MICHIGAN STATE UNIVERSITY | COMPARE SCENARIOS

HOME | CREATE | COMPARE

Model ver BAU 2013.1112 **Business As Usual**	Scenario **Utility Scale Wind: 18MW**	Scenario **Conservation and PV**	Scenario **Renewables w/ PPA**
Key Metrics:	Key Metrics:	Key Metrics:	Key Metrics:
FISCAL STEWARDSHIP	FISCAL STEWARDSHIP	FISCAL STEWARDSHIP	FISCAL STEWARDSHIP
Cost of Utility Service	Cost of Utility Service	Cost of Utility Service	Cost of Utility Service
Cost of Utility Service w/ GHG Price	Cost of Utility Service w/ GHG Price	Cost of Utility Service w/ GHG Price	Cost of Utility Service w/ GHG Price
Required Capital	Required Capital	Required Capital	Required Capital
Cumulative Required Capital	Cumulative Required Capital	Cumulative Required Capital	Cumulative Required Capital
Scenario Debt	Scenario Debt	Scenario Debt	Scenario Debt
OPERATIONAL EXCELLENCE	OPERATIONAL EXCELLENCE	OPERATIONAL EXCELLENCE	OPERATIONAL EXCELLENCE
Steam Tipping Point - Nov	Steam Tipping Point - Nov	Steam Tipping Point - Nov	Steam Tipping Point - Nov
Electric Tipping Point - Sept	Electric Tipping Point - Sept	Electric Tipping Point - Sept	Electric Tipping Point - Sept
Overall Plant Efficiency	Overall Plant Efficiency	Overall Plant Efficiency	Overall Plant Efficiency
Building Energy Intensity	Building Energy Intensity	Building Energy Intensity	Building Energy Intensity
Campus Energy Intensity	Campus Energy Intensity	Campus Energy Intensity	Campus Energy Intensity
ENVIRON./HEALTH STEWARDSHIP	ENVIRON./HEALTH STEWARDSHIP	ENVIRON./HEALTH STEWARDSHIP	ENVIRON./HEALTH STEWARDSHIP
% Reliance on Coal	% Reliance on Coal	% Reliance on Coal	% Reliance on Coal
GHG Emissions	GHG Emissions	GHG Emissions	GHG Emissions
Renewable Energy	Renewable Energy	Renewable Energy	Renewable Energy
METRIC DASHBOARD			
Description:	Description:	Description:	Description:
BAU with no FRIB Adjustment	Utility Scale Wind: 18MW Capacity	$50 Million over 5 years in conservation and 5MW of PV.	Combination of Wind and Geothermal resources
Technologies Used:	Technologies Used:	Technologies Used:	Technologies Used:
2.0 million GSF per Decade	Utility-scale Wind 2.0 million GSF per Decade	Building Integrated Photovoltaics Energy Conservation 2.0 million GSF per Decade	Thermal Storage Green Power Purchases Building Integrated Photovoltaics Utility-scale Wind Capital Plan Growth Management Construction Standards Energy Conservation 2.0 million GSF per Decade


Fiscal Stewardship: Cost of Utility Service: Cost of Utility Service
80M
75M
70M
65M
60M
55M
50M
2014$
2014
2019
Year
Reference Case
Utility Scale Wind: 18MW
Conservation and PV
Renewables w/ PPA
10 years
20 years
All
Hide All Series | Show All Series


Environ./Health Stewardship: GHG Emissions: GHG Emissions
600k
500k
400k
300k
200k
100k
0k
MTCO2e
2014
2019
2024
2029
Year
ETP GHG Target
Reference Case
Utility Scale Wind: 18MW
Conservation and PV
Renewables w/ PPA
10 years
20 years
All
Hide All Series | Show All Series

Home | Model Architecture | Sensitivity | Business Plan

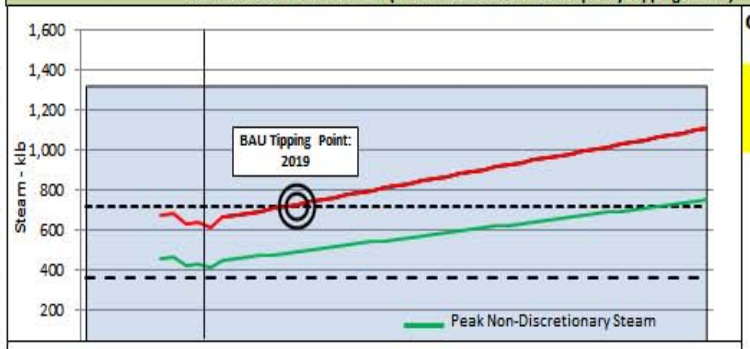
Baseline Reference Case	
Establish Baseline Reference Case	
Energy Management Portfolio Planning	
Demand Related Options	"X" to Include
Demand Related Options Combination	
Supply Related Options	"X" to Include
Expand Grid Purchases (Reduce Condensing)	
Expand Combustion Turbine Generation	
Expand NG Use in Coal Boilers	
Expand Biomass Use in Coal Boilers	
GeoExchange	
Small Scale Nuclear	
Boiler 3 MACT Compliance - New Gas Cogen	
Boiler 3 MACT Compliance - New Gas Boiler	
Building Integrated Solar PV	
On-site, Small-scale Wind	
Torrefied Wood	
Scenario 4 (Gasifier Only)	
Large Scale Wind	
FRIB BV1: New Substation - MSU Owned	
FRIB BV1 w/ displaced condensing	
FRIB BV3: New CTG/HRSG	
FRIB BV3 w/ displaced condensing	
FRIB BV3 + 18MW Wind	
Anaerobic Digester	
Other	"X" to Include
Green Power to Electricity Usage Max	

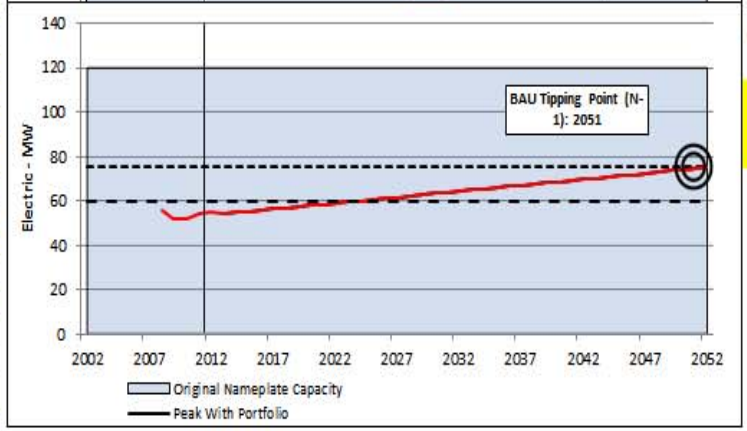
Steam Operator Buffer (klb)	20
Include Non-Central Gas	X
Include Non-Central Electric	X

OUTPUTS - Incremental Changes from Reference Case

FISCAL STEWARDSHIP	REFERENCE CASE	W/ PORTFOLIO	CHANGE	UNIT
Cost of Utility Service (w/o GHG Financial Exposure)				
2021	$74.8	$74.8	$0.0	2013$ millions
Forecast Horizon (Present Value through 2052)	$2,133	$2,133	$0.0	2013$ millions PV
Required Capital				
1-5 Years	$26	$26	$0	2013$ millions
6-10 Years	$18	$18	$0	2013$ millions
Capital Present Value through 2052	$133	$133	$0	2013$ millions PV

OPERATIONAL EXCELLENCE (T.B. Simon Power Plant Capacity Tipping Points)





Overall Plant Efficiency

	Reference Case
2015	63%
2020	63%
2025	64%

	w/ Portfolio Scenario
2015	63%
2020	63%
2025	64%

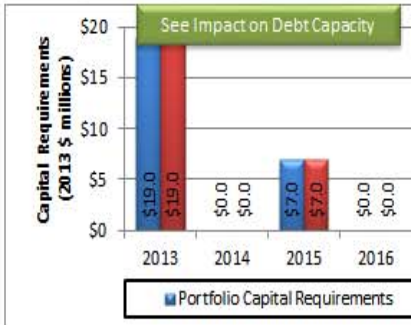
% Reliance on Coal

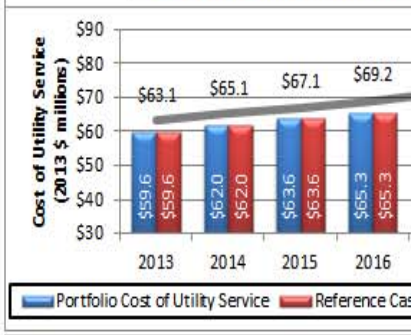
	Reference Case
2015	44%
2020	45%
2025	37%

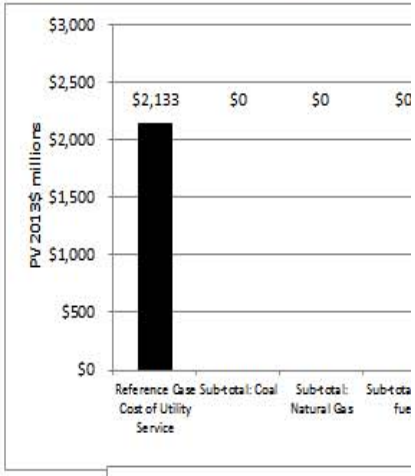
	w/ Portfolio Scenario
2015	44%
2020	45%
2025	37%

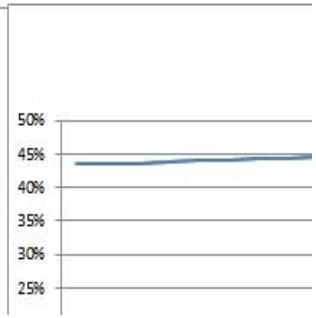
ENVIRONMENTAL STEWARDSHIP	REFERENCE CASE	W/ PORTFOLIO	CHANGE vs. Base Year	CHANGE vs. Ref Case	UNIT
GHG Emissions					
Base FYE: 2010	458,089	458,089			MTCO2e
2015	463,258	463,258	1%	0.00%	MTCO2e
2020	480,864	480,864	5%	0.00%	MTCO2e
2025	472,780	472,780	3%	0.00%	MTCO2e

Base FYE: 2010









Create a Campus Scenario

MICHIGAN STATE UNIVERSITY

MICHIGAN STATE UNIVERSITY | Scenario List

Welcome, wjlakos@pplant.msu.edu

EXPLORE | CREATE | COMPARE | MANAGE

Integrated Energy Planning

Step 1: Create New Scenario → CREATE NEW SCENARIO

My Energy Scenarios

Only My Scenarios | Include all Published Scenarios

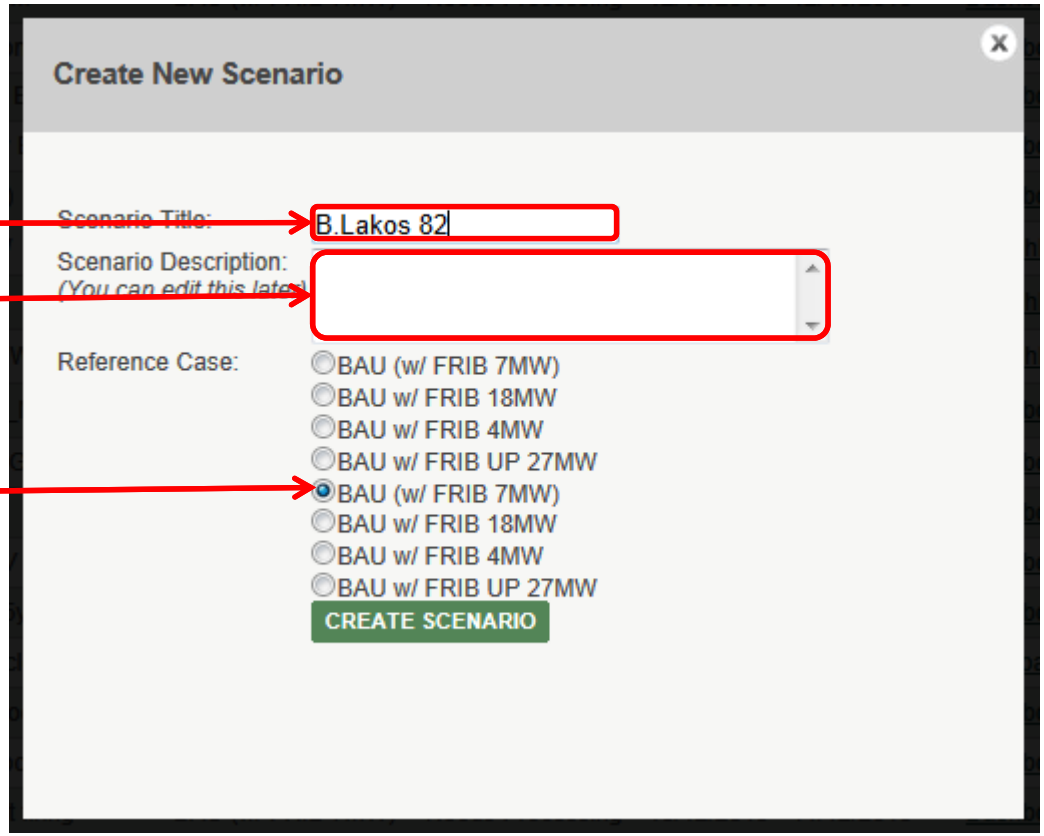
	Scenario Name	Ref Case	Visibility	Created	Updated	
	$7 Green Power Purchase w/ 10MW Block	BAU (w/ FRIB 7MW)	Needs Processing	10/17/2013	10/23/2013	Dashboard | Compare | Copy | Delete
	25 MW Offsite PV Farm	BAU (w/ FRIB 7MW)	Needs Processing	12/13/2013	12/16/2013	Dashboard | Compare | Copy | Delete
	5 MW Solar Installation	BAU (w/ FRIB 7MW)	Needs Processing	9/27/2013	10/25/2013	Dashboard | Compare | Copy | Delete
	All Absorption to Electric EOL	BAU (w/ FRIB 7MW)	Needs Processing	9/20/2013	1/30/2014	Dashboard | Compare | Copy | Delete
	All Absorption to Stm Drv EOL	BAU (w/ FRIB 7MW)	Needs Processing	9/20/2013	10/23/2013	Dashboard | Compare | Copy | Delete
	BAU (w/ FRIB 7MW)		Needs Processing	7/9/2013	1/16/2014	Dashboard | Compare | Copy | Delete
	BAU w/ FRIB 18MW		Published	7/9/2013	11/12/2013	Dashboard | Compare | Copy | Delete
	BAU w/ FRIB 4MW		Published	7/9/2013	11/12/2013	Dashboard | Compare | Copy | Delete
	BAU w/ FRIB UP 27MW		Published	7/9/2013	11/12/2013	Dashboard | Compare | Copy | Delete
	Boomer_FRIBwith25MWPV_NatGas	BAU w/ FRIB 18MW	Draft - Publish...	12/13/2013	12/13/2013	Dashboard | Compare | Copy | Delete
	Chiller Change w/ CTG	BAU (w/ FRIB 7MW)	Needs Processing	9/29/2013	10/23/2013	Dashboard | Compare | Copy | Delete
	CHP	BAU (w/ FRIB 7MW)	Needs Processing	10/16/2013	10/23/2013	Dashboard | Compare | Copy | Delete
	Conservation and PV	BAU (w/ FRIB 7MW)	Needs Processing	9/27/2013	12/18/2013	Dashboard | Compare | Copy | Delete

Step 2: Name, Description and Reference Case

Name Scenario (unique)

Describe Scenario (helpful when sharing with others)

What to Compare Against?



Demand Profiles – Building Construction

MICHIGAN STATE UNIVERSITY

B.Lakos Class Example wjlakos@pplant.msu.edu

PROCESS... REVIEW & PUBLISH

Utility Costs	Required Capital	Tipping Points	GHG Emissions	% Renewables
No Change	No Change	2018 (steam) 2015 (elec)	No Change	-- (2030)

Timeline

OVERVIEW CAPITAL PLANS SPACE FORECAST

Demand Profiles

CAPITAL PLANS

- None
- Capital Outlay Request
- Projects before 2018
- Projects before 2020
- Large Projects Only

SPACE FORECAST

- Low, Historic Mix
- Low, Research Mix
- Average, Historic Mix
- Average, Research Mix
- High, Historic Mix
- High, Research Mix

CONSTRUCTION STANDARDS

- MSU Standard
- High Performance Labs
- High Performance Non-Labs
- High Performance
  Labs: 40% (156 kbtu/sf)
  C/O/S: 40% (62 kbtu/sf)
  Res. Life: 40% (77 kbtu/sf)
  Other: 40% (139 kbtu/sf)
- Super High Performance
- Super High Performance Labs
- Super High Performance Non-Labs

SPECIAL PROJECTS

- None
- FRIB with 4MW Backup
  MSU provides electrical power backup for Cryoplant loads (4MW). All other FRIB electrical needs are provided from non-university sources.
- FRIB with full Backup (18MW)
- FRIB with Upgrade (27MW)

* Reference Case Setting

Step 3: Define parameters related to construction and renovations of buildings

Demand – Energy Conservation Portfolios

MICHIGAN STATE UNIVERSITY

B.Lakos Class Example wjlakos@pplant.msu.edu

PROCESS... REVIEW & PUBLISH

Utility Costs	Required Capital	Tipping Points	GHG Emissions	% Renewables
No Change	No Change	2018 (steam) 2015 (elec)	No Change	-- (2030)

Timeline

OVERVIEW ECM PORTFOLIOS

ECM Portfolios

Select one of these for a pre-configured ECM portfolio

Box size: Time to Payba

18MW WIND EQUIVALENT
Lab ECMS 10 yrs or less
175,000 MMBTU
testPA1
$36MM
$10 Million invested every 3 years
50 Mil over 5 Years
50 M with Commissioning

ECM

ECM Portfolio

Collapse

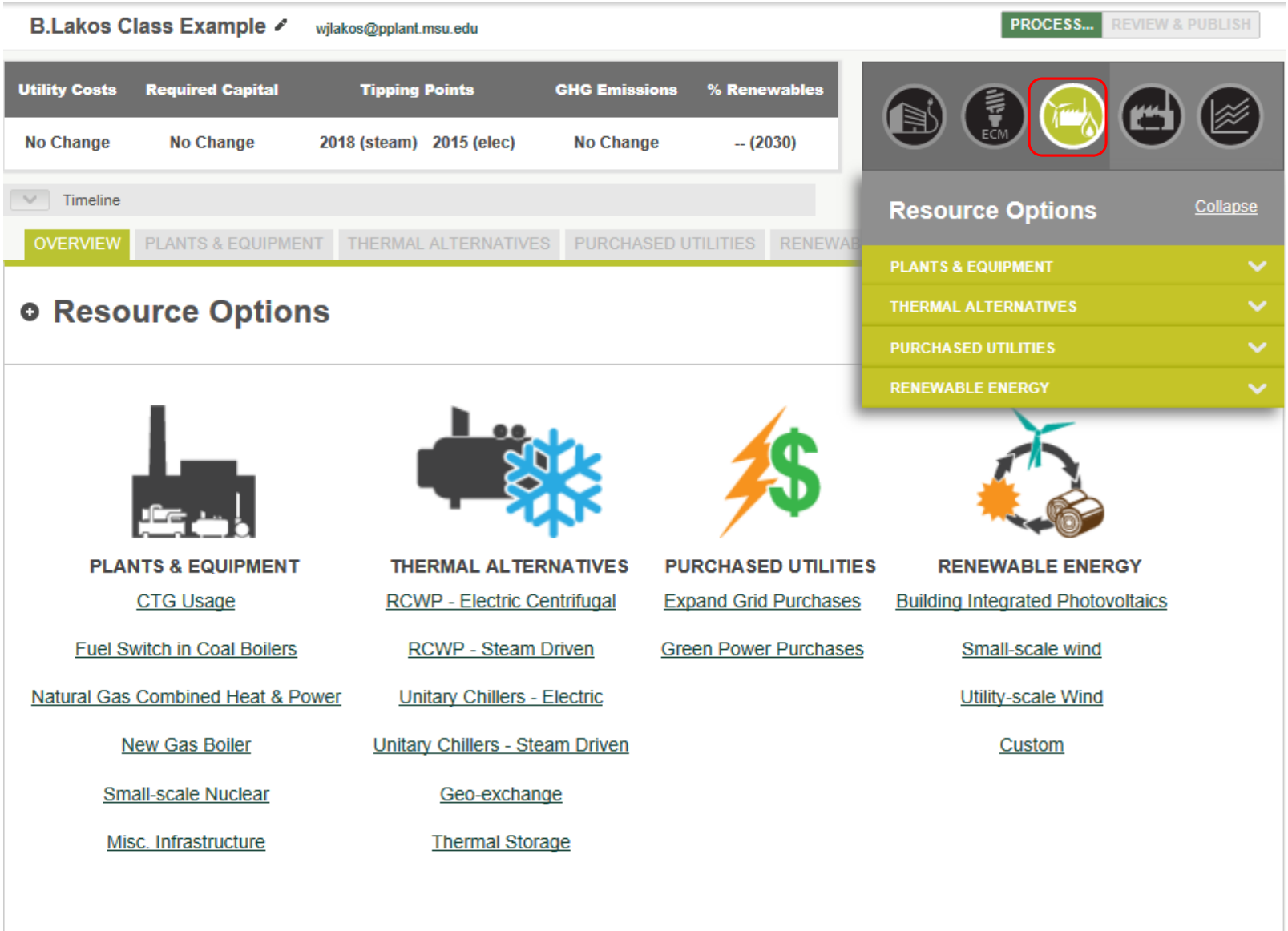
Select an Energy Conservation Measure (ECM) Portfolio from the available list below or create a Custom ECM Portfolio

TITLE	SIMPLE PAYBACK
NO ECM PORTFOLIO	
$36MM	5.89
175,000 MMBTU	3.73
BATTLE BASE DEMAND	11.18
18MW WIND EQUIVALENT	2.15
$10 MILLION INVESTED EVERY 3 YEARS	7.84
40M	11.34
50 M WITH COMMISSIONING	8.46
LAB ECMS 10 YRS OR LESS	3.43
ALL LAB ECMS	4.68
50 MIL OVER 5 YEARS	8.19
TESTPA1	5.84

Step 4: Select a configured ECM Portfolio

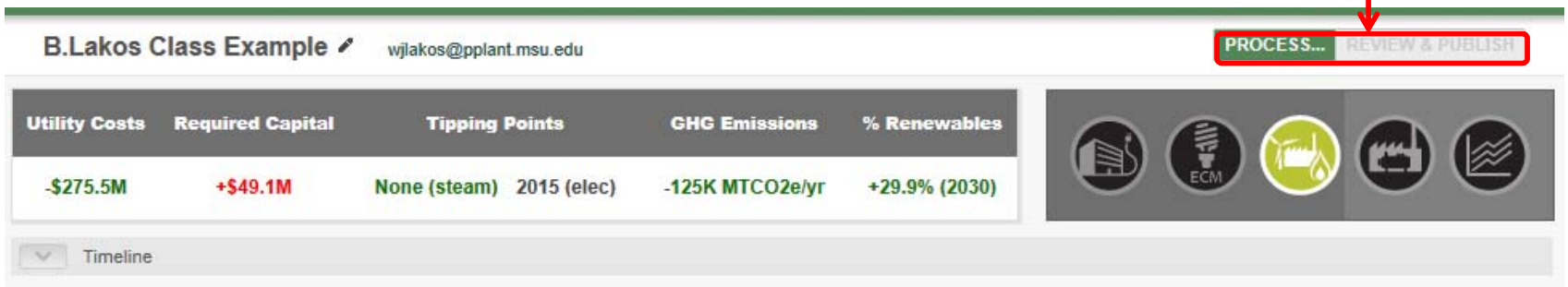
Demand – Energy Conservation Portfolios

MICHIGAN STATE UNIVERSITY



Step 5: Determine Resource Options

Final Steps:
Process
Review and Publish



THANK YOU !

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