Pennsylvania's Solar Future

Kickoff Meeting

March 2, 2017

Harrisburg, PA

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

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U.S. Department of Energy

Vermont Energy Investment Corporation

Overview

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- Background on VEIC
- Research objectives
- Approach and tools
  - Brief examples from VT Solar Market Pathways
- Process
- Scenario modeling
- Structure
- Current accounts
- Initial reference scenario
- Data and other feedback
- Next steps

About VEIC

- Private, nonprofit corporation founded in 1986
- Provides energy efficiency and renewable energy consulting and implementation services
- 300+ employees
- Locations: VT, DC, NJ, OH

Major Initiatives

VEIC Consulting and Implementation

Areas of Expertise

- Policy development & regulatory support
- Program delivery structure
- Market research & analysis
- Program design & implementation
- Project feasibility & technology suppor
- Transportation research & policy

Range of Clients

- Regulators
- Government agencies
- Advocates
- Utilities – IOUs, munis, co-ops
- Foundations

Range of Jurisdictions

- 28 states, 6 Canadian provinces
- China, Vietnam, Mexico, Ireland, United Kingdom, others

VEIC work in the United States

Research Objectives

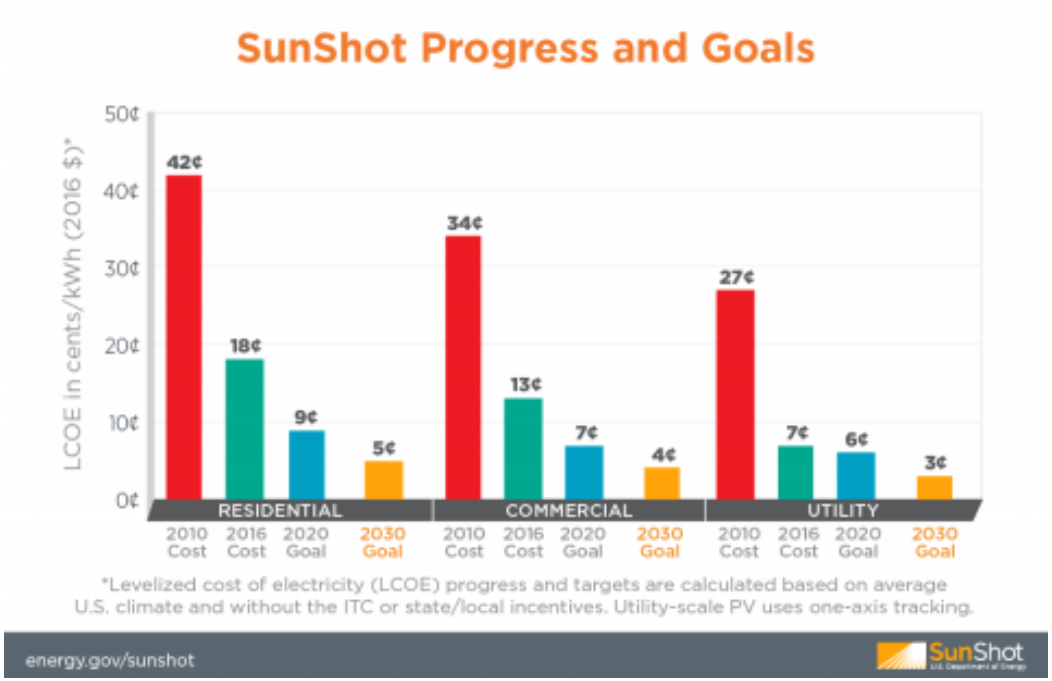
- Research Objectives
  - Convene and engage stakeholders to inform analytically based discussions and report on Pennsylvania's Solar Future
  - Scenarios place solar in context of total energy economy
  - Initial Solar Scenario of 10% of sales by 2030
  - Accurate and transparent accounting – compare energy flows, costs and other impacts between scenarios
  - Support 3 Focus Areas
    - Regulatory and ratemaking
    - Incentives, markets and business models
    - Operations and system integration
  - Multi-audience reporting and communications

Sun Shot Initiative

- Launched 2011

  More than $500 million for 350+ projects
  - PV
  - CSP
  - Balance of system (soft costs)
  - Systems integration
  - Tech to market

  Objectives to reduce costs of solar to $0.06 / kWh by 2020, and further by 2030



Research Approach

Stakeholder engagement

- Create a common frame and analytic support
- Review and vetting, ideas for alternative scenarios

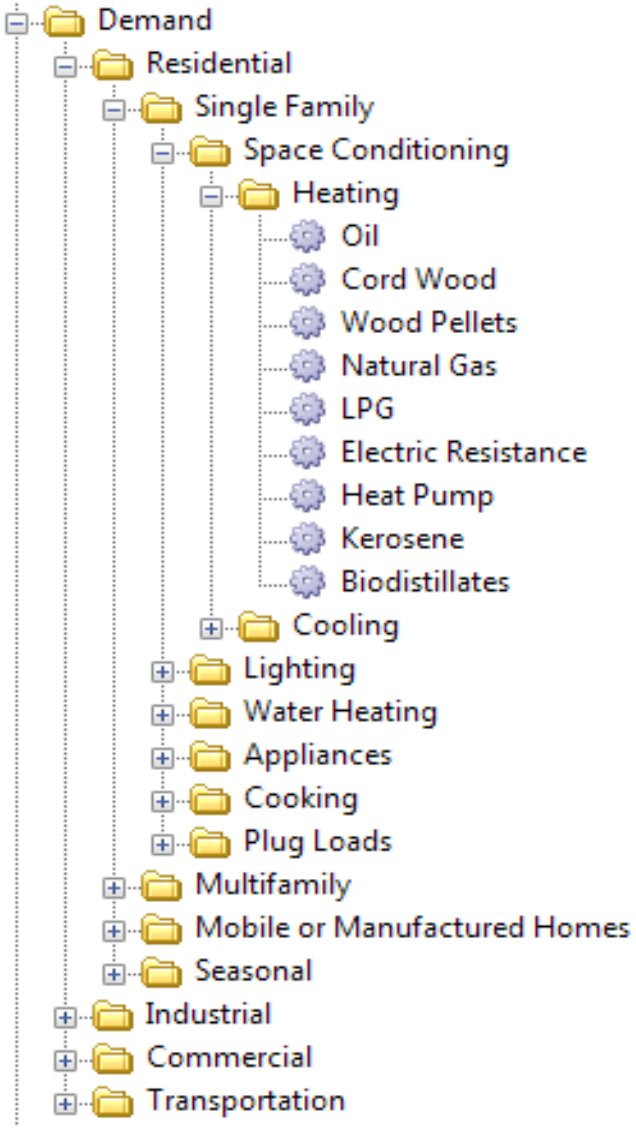
Scenario Modeling

- Define possible future state(s)
- Compare to business as usual and other paths
- Examine issues
- Estimate costs and impacts

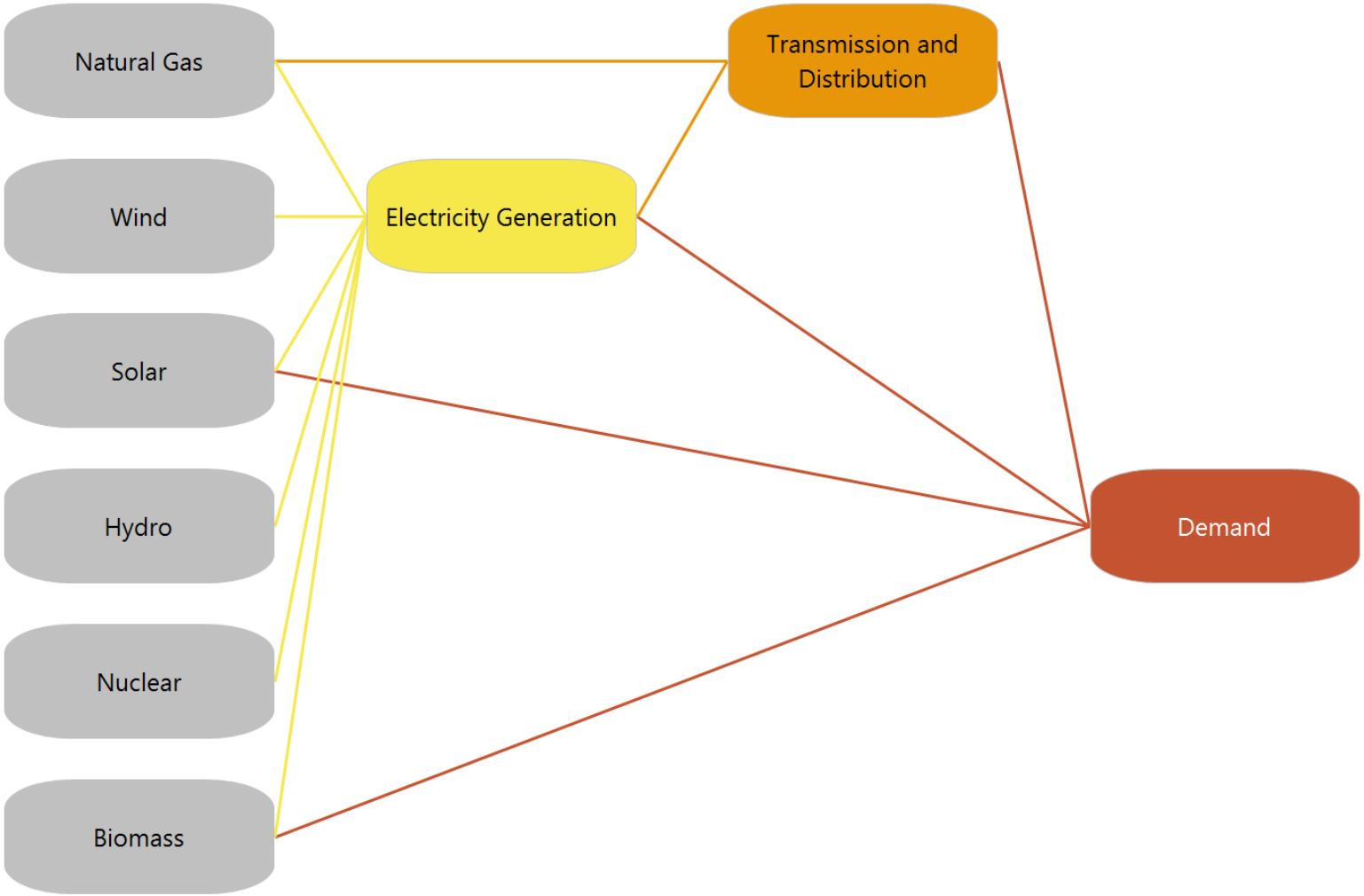
LEAP System

- **L**ong-range **E**nergy **A**lternatives **P**lanning System
- Developed / maintained by Stockholm Environment Institute
- Decades of application and development in > 190 countries worldwide
- Scenario based: “self-consistent story lines of how an energy system might evolve over time”; well suited for regional and targeted technology (Solar Development Pathways) analyses
- Transparent accounting framework

Demand Driven



Resources ← Transformation ← Demand Driven



PA Solar Future: Scenarios

Reference

Business as usual, expanding natural gas and cars becoming more efficient because of CAFE standards

AEPS – consistent with solar and EE goals by 2021

PA Solar Future (initial)

Meets 10% of electric sales from solar generation by 2030

Options to Consider

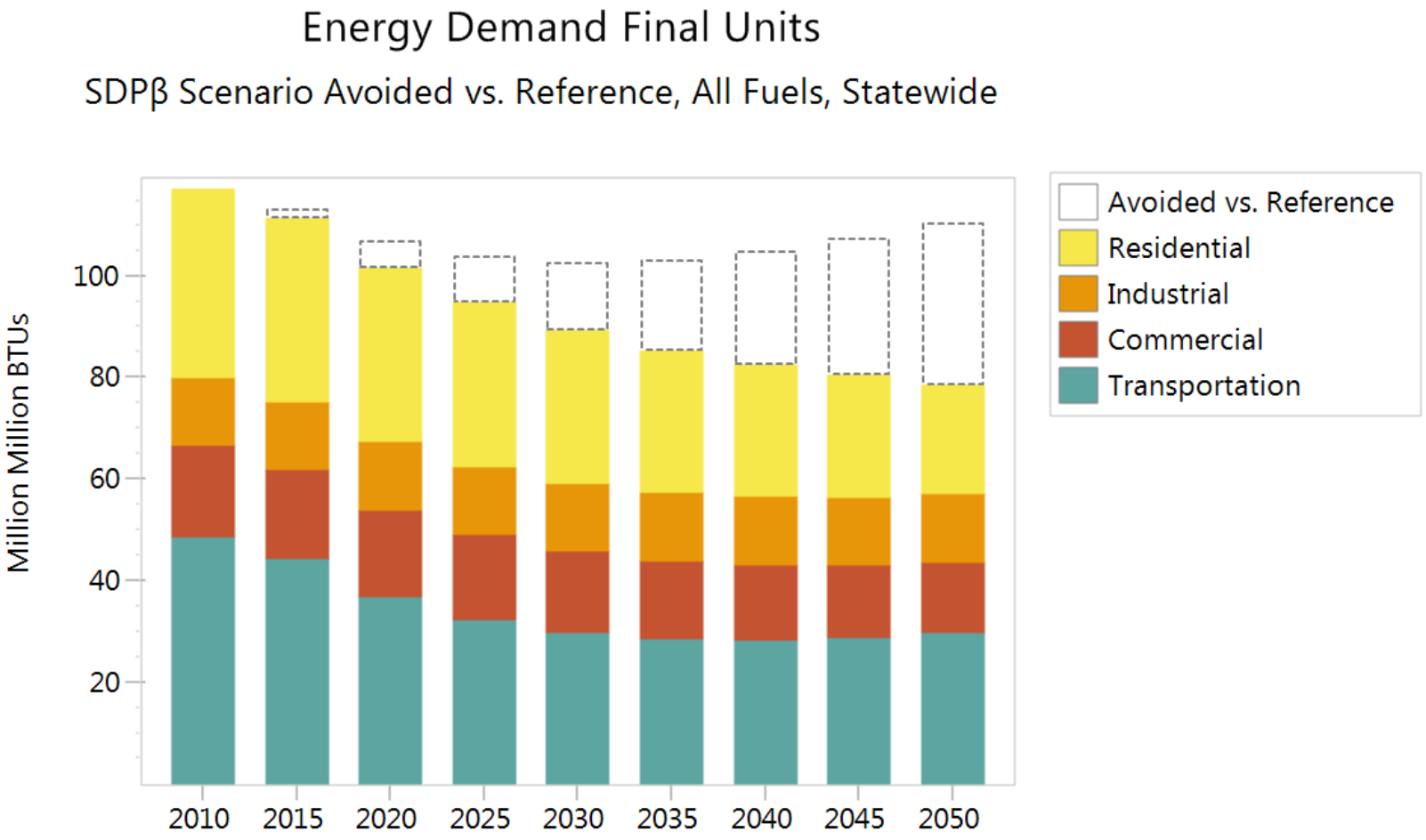
- Mix of customer sited/central
- Growth of electric end uses
  - heat pumps, electric vehicles
- Storage, demand response, load shaping
- Siting and geographic diversity

Vermont as an Advanced Solar Economy

20% of electricity generation from solar by 2025

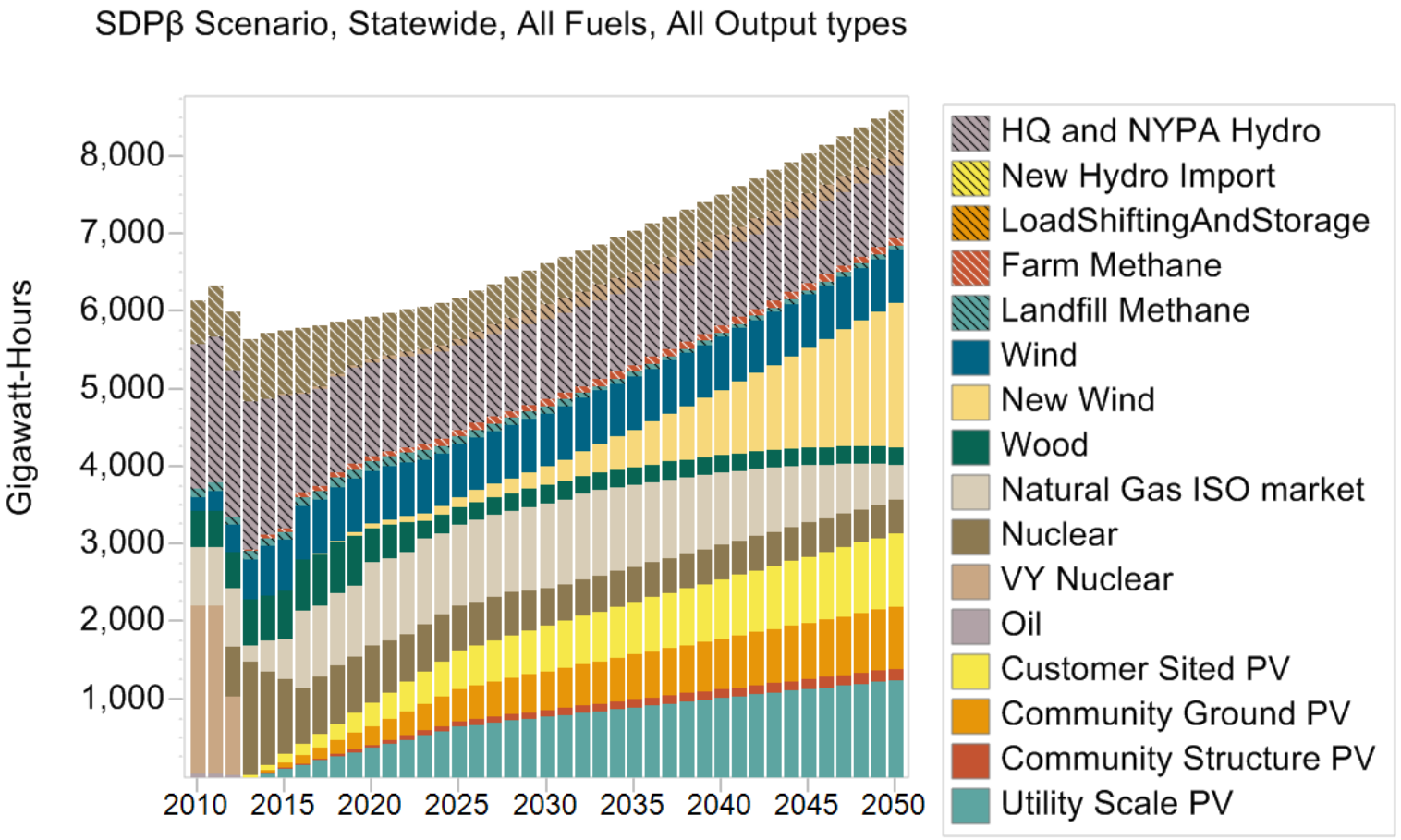
Ferrisburgh Solar Farm, segroup.com

Example from Vermont – Solar Market Pathways

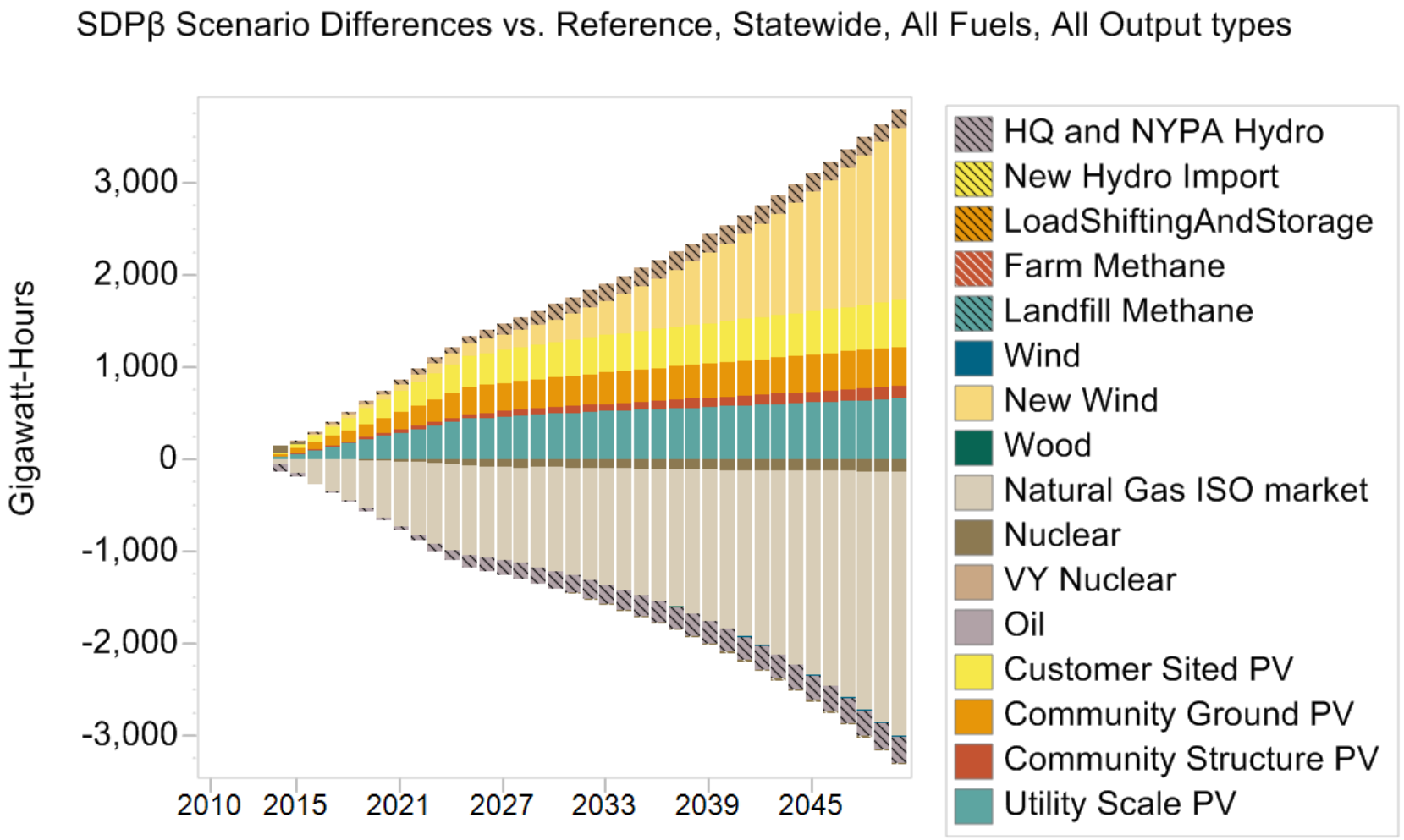


Heaps, C.G., 2012. Long-range Energy Alternatives Planning (LEAP) system. [Software version 2014.0.1.20] Stockholm Environment Institute. Somerville, MA, USA. www.energycommunity.org

Vermont Example: Generation by Year

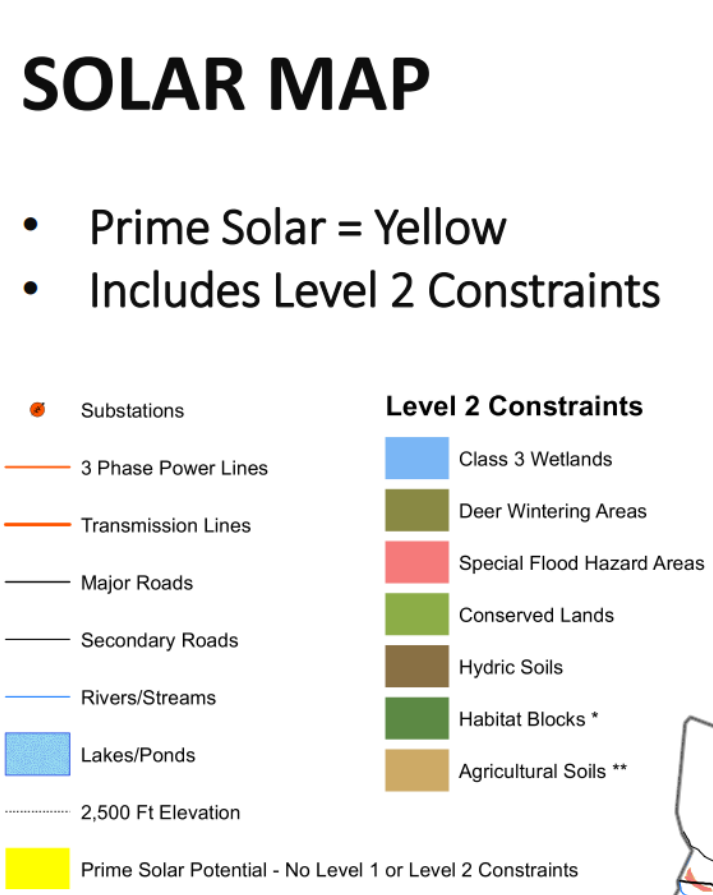


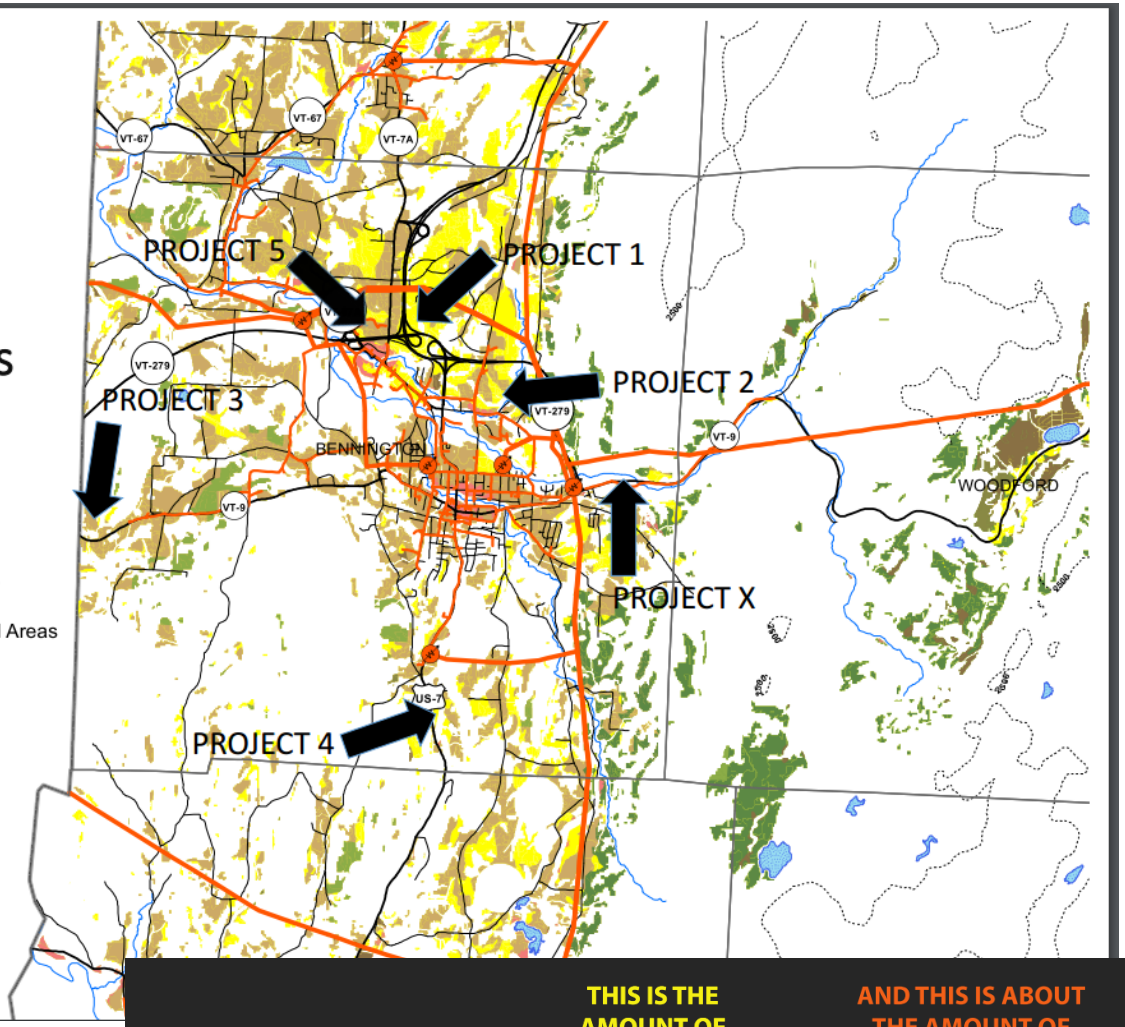
Generation by Year - Difference from Reference



SOLAR MAP

- Prime Solar = Yellow
- Includes Level 2 Constraints





THIS IS THE AMOUNT OF LAND AREA IN THE BCRC REGION

(about 370,00 acres, or 575 sq. miles)

THIS IS THE AMOUNT OF THAT AREA WHICH IS CONSIDERED "PRIME SOLAR."

(about 14,000 acres)

AND THIS IS ABOUT THE AMOUNT OF AREA THAT WOULD BE NEEDED TO REACH OUR 2050 GOAL OF 85 MW ADDITIONAL IN-REGION CAPACITY.

(about 800 acres)

Images provided by Bennington Regional Planning Commission, 2016

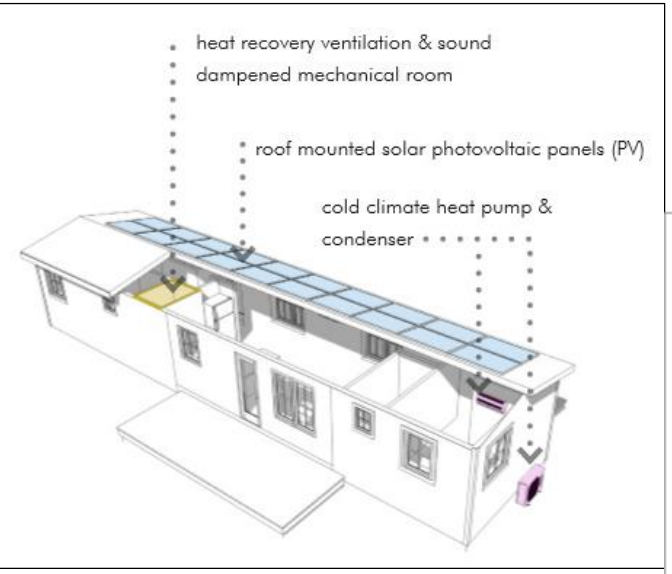
VT Example: Economic Results

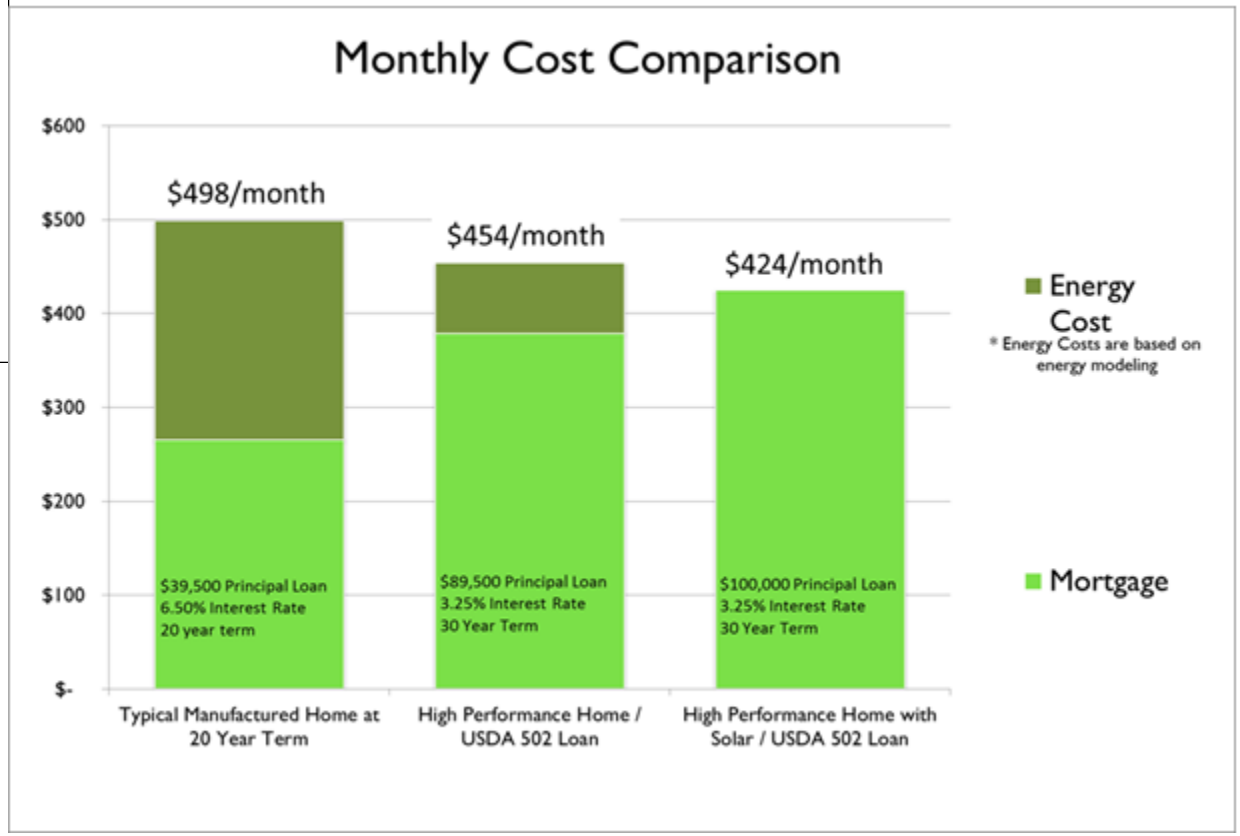
- Significant investments in efficiency across all sectors and in solar.
- Benefits from reductions of fossil and electric imports
- Net investments less than 1% of annual expenditures
- By early 2030's net positive benefits – by 2050 close to $8 billion net economic benefit to state's economy.

Table 3. Cumulative costs and benefits of SDP relative to the Reference scenario, 2010-2025, discounted at 3 percent to 2013

	SDP_{β} $ million (2013)
Demand	**$ 851**
Residential	$ 416
Commercial	$ 261
Industrial	$ 58
Transportation	$ 115
Transformation	**$ 498**
Transmission and distribution	$ 13
Electricity generation	$ 485
Resources	**-$ 1,140**
Production	$ 83
Imports	-$ 1,222
Exports	-
Unmet requirements	-
Environmental externalities	-
Non-energy sector costs	-
Net present value	**$ 209**
GHG savings (million tonnes CO2e)	**7.1**
Cost of avoiding GHGs (U.S. dollar / tonne CO2e)	**$ 29**

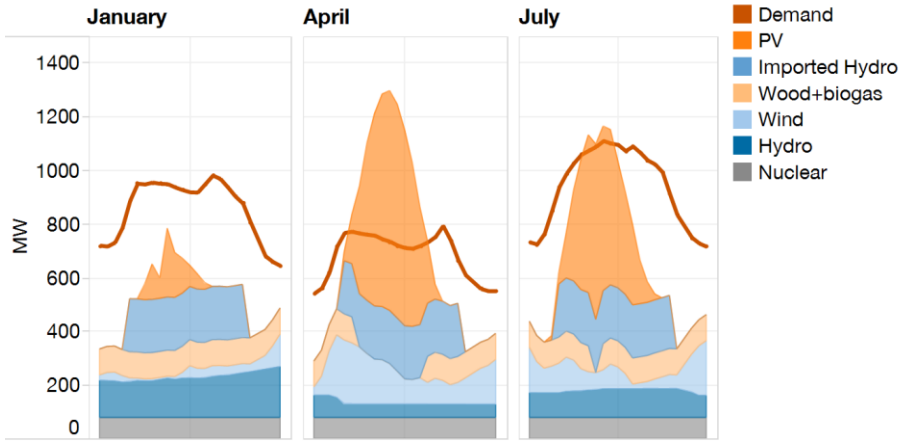
Consumer perspective and social equity

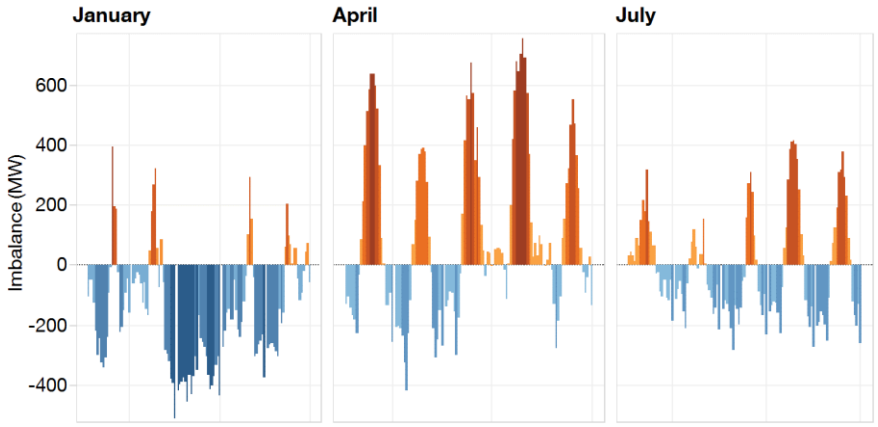




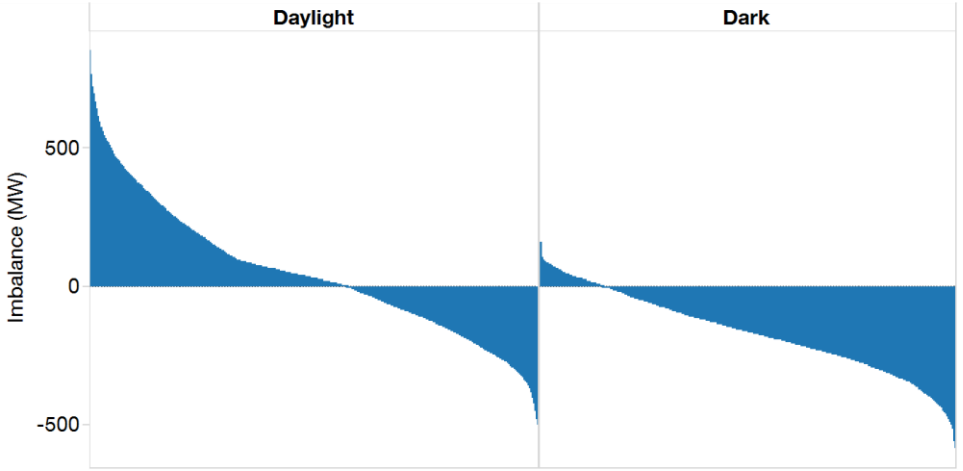
VT Example: Technical Results

Supply and demand on difficult days

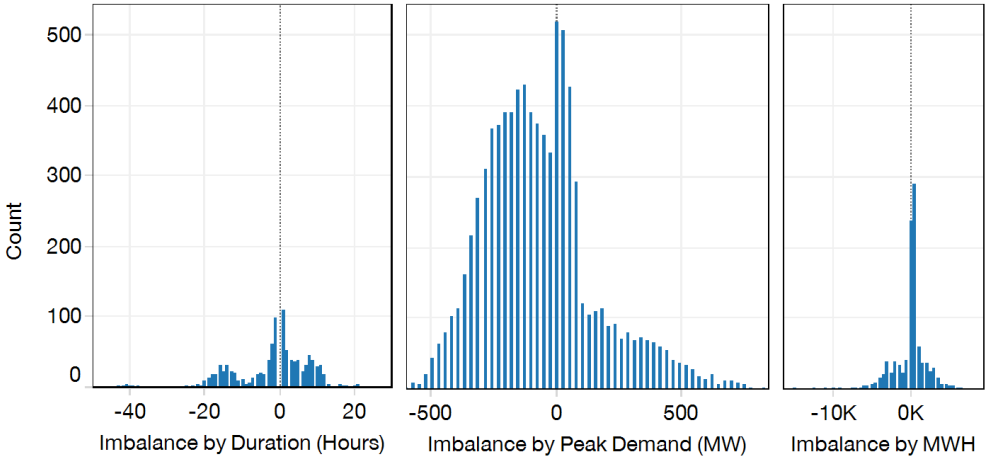




Imbalance duration curves

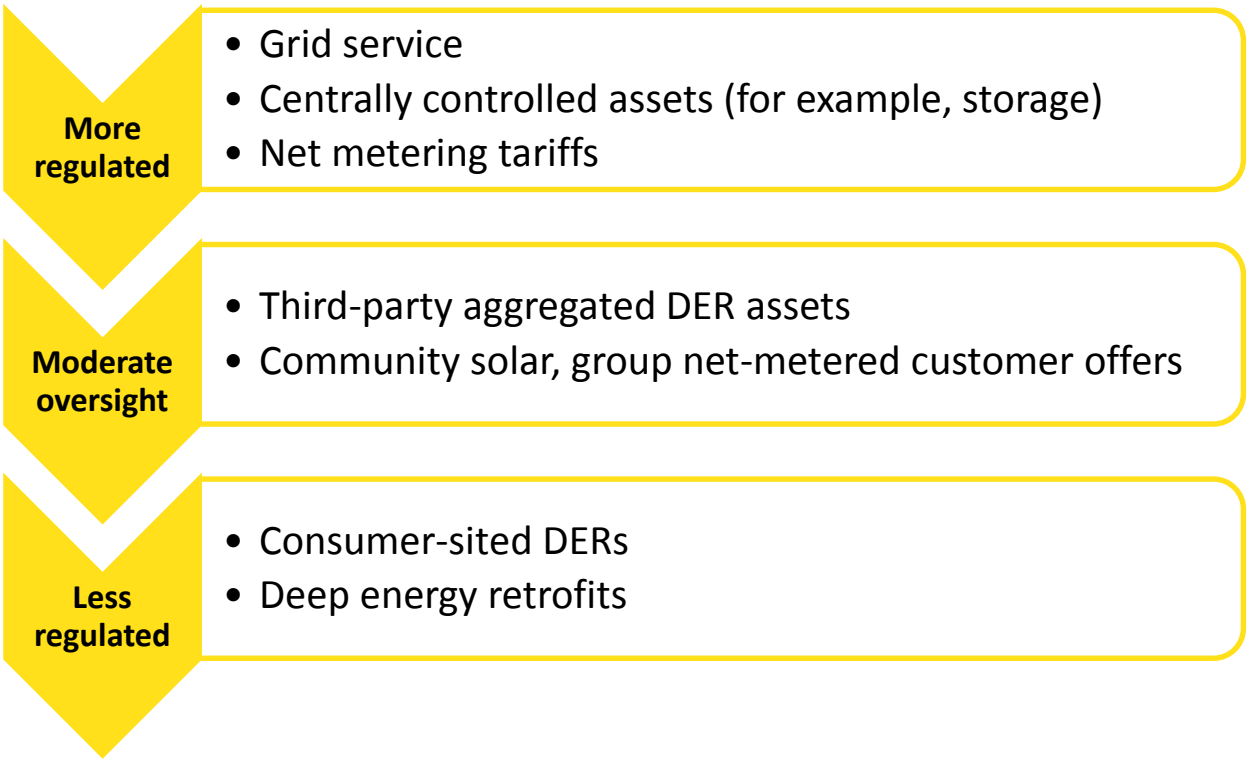


Imbalance histograms



Business and regulatory models

- Examples to prompt further discussions and options



ISO Distributed Generation Working Group

Historical Installed PV Capacity Survey Results

December 2013 - December 2016 (MW_{AC})

Survey Date	CT	ME	MA	NH	RI	VT	New England
Dec 2013	73.75	8.12	361.55	8.22	10.90	36.13	498.67
Apr 2014	78.42	8.51	434.39	9.35	15.29	29.40	575.36
Aug 2014	98.02	8.16	550.54	10.17	15.52	66.55	748.96
Dec 2014	118.80	10.38	656.73	12.74	18.21	81.85	898.71
Apr 2015	133.83	11.04	739.48	13.93	19.08	90.76	1,008.12
Aug 2015	158.73	12.43	855.03	18.37	21.51	108.27	1,174.34
Dec 2015	188.01	15.34	947.11	26.36	23.59	124.57	1,324.98
Apr 2016	215.56	19.54	1,069.85	33.11	25.74	139.13	1,502.90
Aug 2016	246.45	19.83	1,173.56	43.77	32.21	151.22	1,667.04
Dec 2016	281.55	22.14	1,324.77	54.30	36.81	198.39	1,917.96

Reflects statewide aggregated PV data provided to ISO by regional Distribution Owners. Values represent installed megawatt AC (MW_{AC}) nameplate.

ISO NE

Process

- Introduce objectives, approach and process
- Orient Stakeholders to the research methods
- Through discussion and dialogue, obtain stakeholder input on data and key areas of focus for the project

- Stakeholders asked to:
  - Provide input on the strategic direction of the project
  - Offer subject matter expertise for key areas of focus
  - Help inform project findings and recommendations

- Key opportunities and or barriers
- What are we missing, what are priorities that you see today that we may be able to address?

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Scenario Modeling

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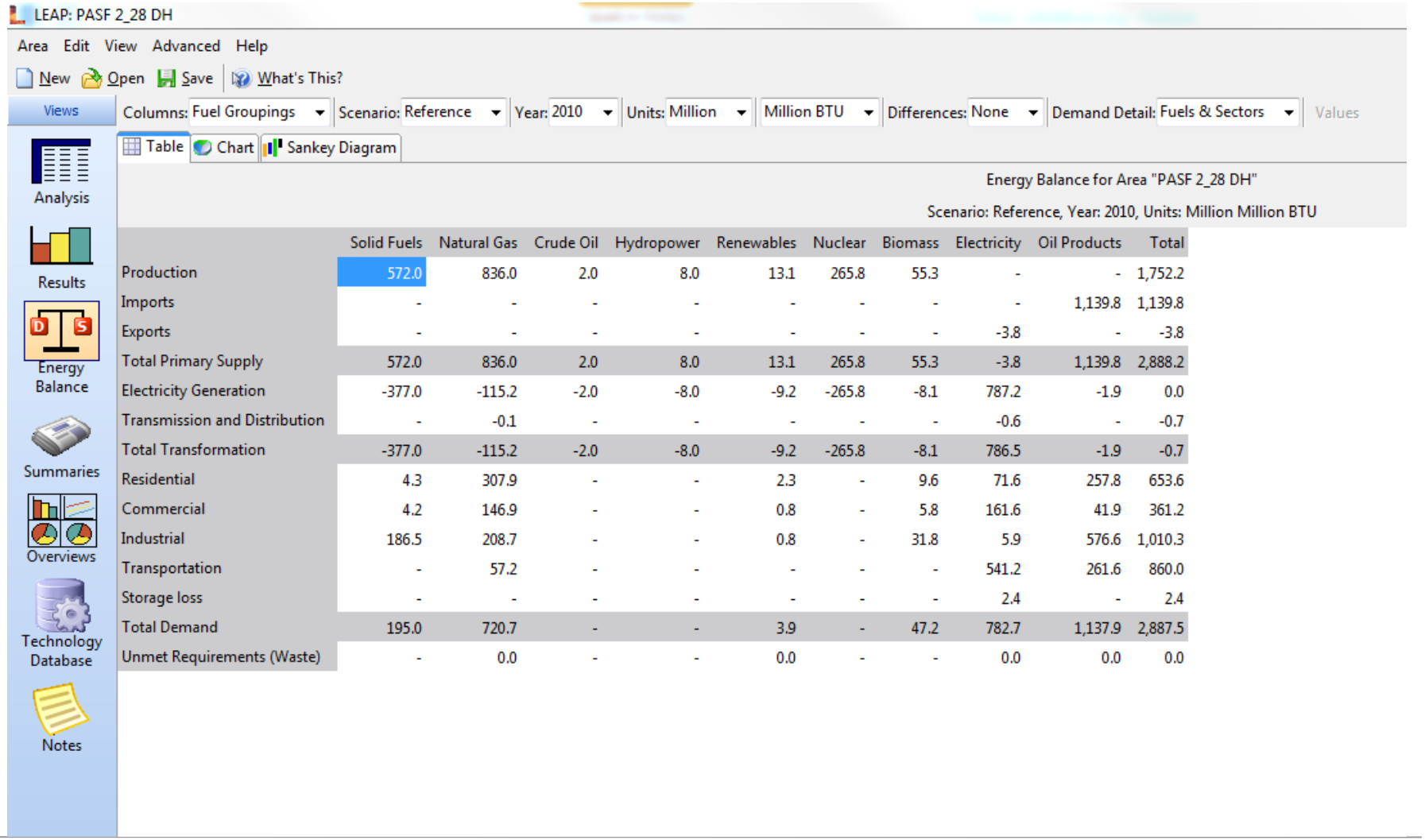
Analytic Approaches

- Model will be technology honest, but not technology agnostic (solar growing to 10% target)
- Compare to reference and AEPS scenarios
- Solar not in a vacuum; part of total energy economy
- Start at high level; build depth through Focus Areas and stakeholder inputs on scenarios
- Utility territories as regions or urban/rural

Initial Pennsylvania Modeling

- Caveat: The initial modeling will take 1+ month of analysis and careful calibration checking. The team has only just started modeling for the PA project.
- The materials presented today will help to illustrate the process and structure of the model, but are not yet validated, checked and balanced within the LEAP model.

Current Accounts/Supply Demand Balance

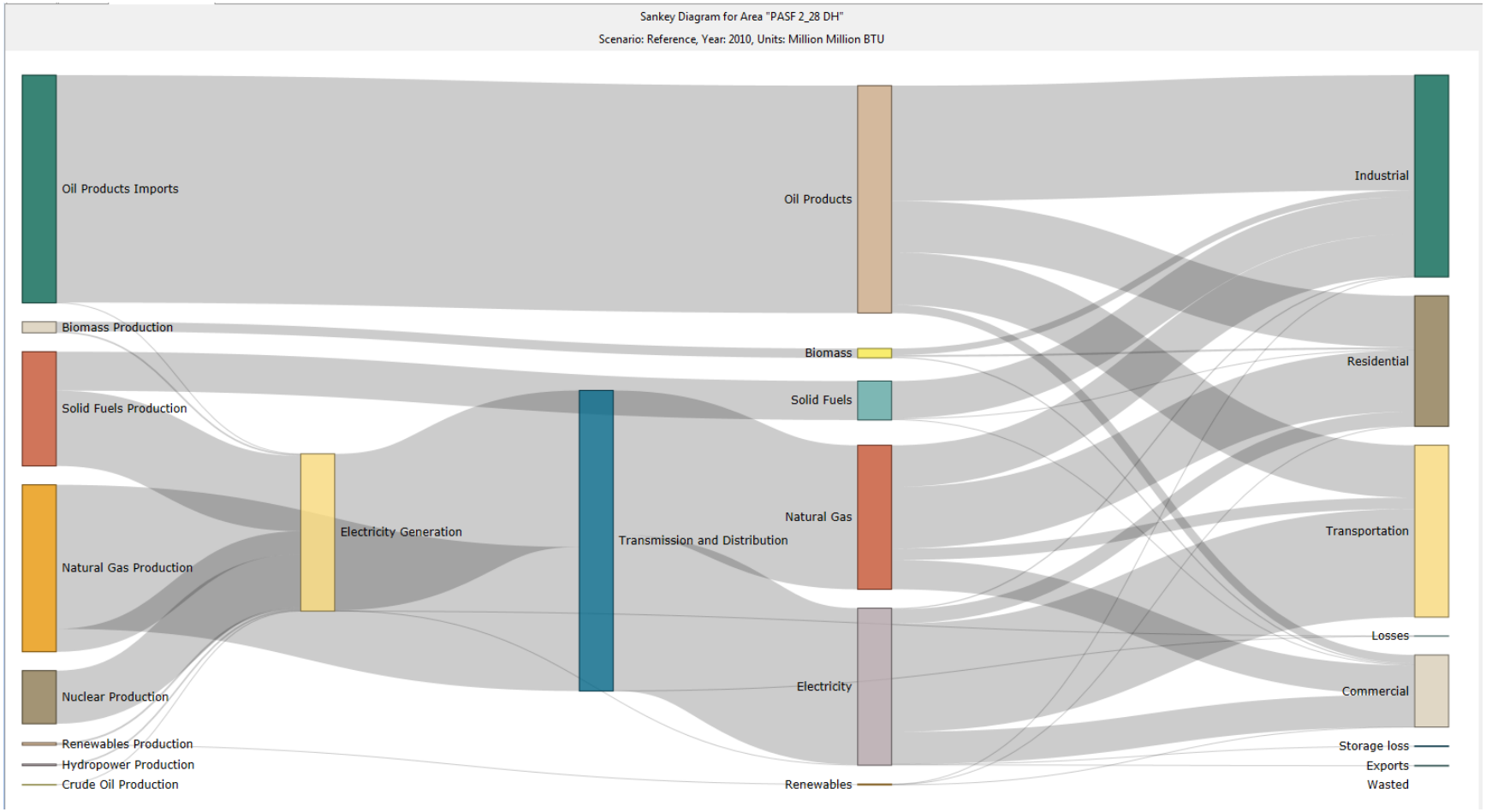


Energy Balance for Area "PASF 2_28 DH"

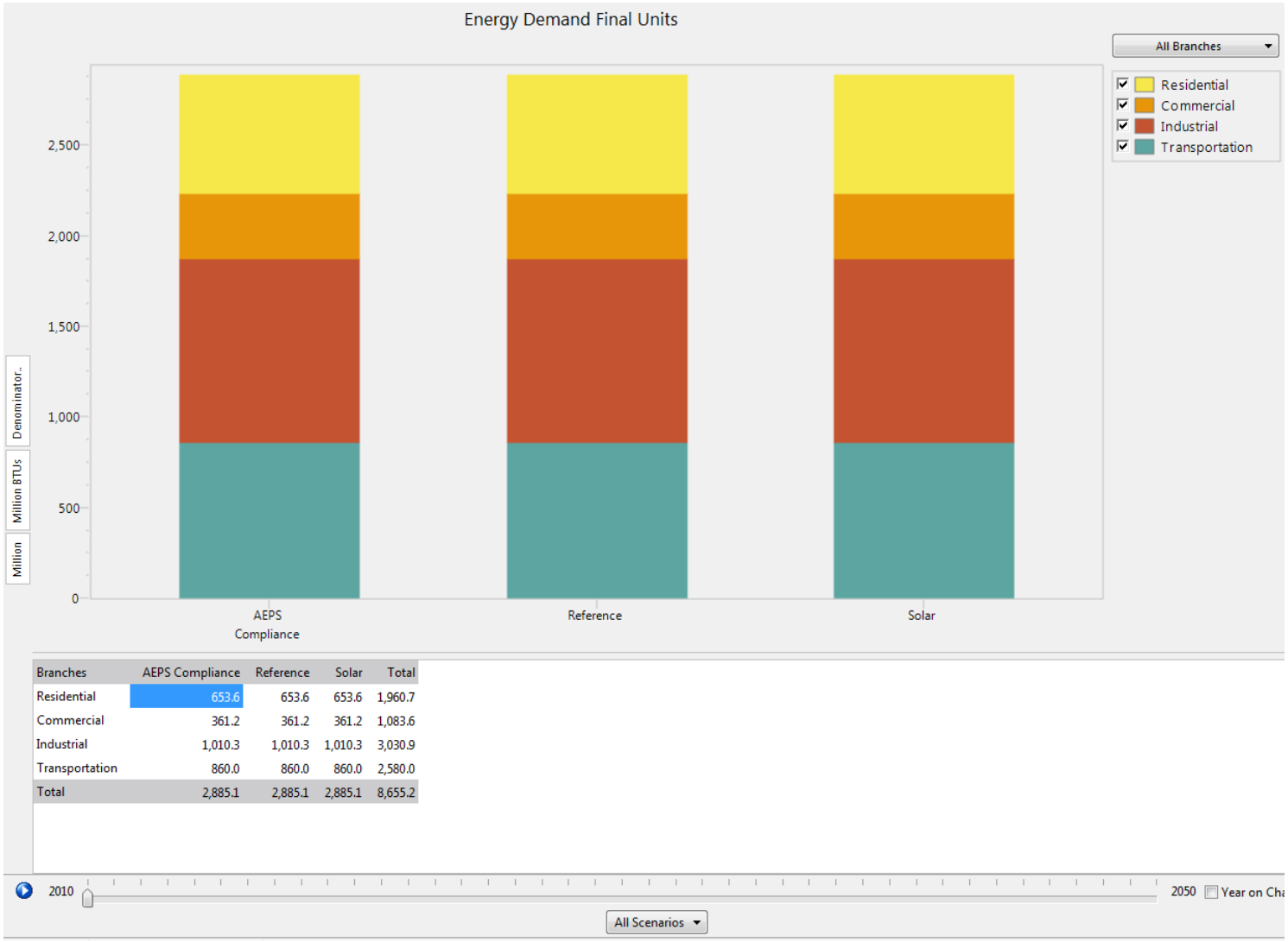
Scenario: Reference, Year: 2010, Units: Million Million BTU

	Solid Fuels	Natural Gas	Crude Oil	Hydropower	Renewables	Nuclear	Biomass	Electricity	Oil Products	Total
Production	572.0	836.0	2.0	8.0	13.1	265.8	55.3	-	-	1,752.2
Imports	-	-	-	-	-	-	-	-	1,139.8	1,139.8
Exports	-	-	-	-	-	-	-	-3.8	-	-3.8
Total Primary Supply	572.0	836.0	2.0	8.0	13.1	265.8	55.3	-3.8	1,139.8	2,888.2
Electricity Generation	-377.0	-115.2	-2.0	-8.0	-9.2	-265.8	-8.1	787.2	-1.9	0.0
Transmission and Distribution	-	-0.1	-	-	-	-	-	-0.6	-	-0.7
Total Transformation	-377.0	-115.2	-2.0	-8.0	-9.2	-265.8	-8.1	786.5	-1.9	-0.7
Residential	4.3	307.9	-	-	2.3	-	9.6	71.6	257.8	653.6
Commercial	4.2	146.9	-	-	0.8	-	5.8	161.6	41.9	361.2
Industrial	186.5	208.7	-	-	0.8	-	31.8	5.9	576.6	1,010.3
Transportation	-	57.2	-	-	-	-	-	541.2	261.6	860.0
Storage loss	-	-	-	-	-	-	-	2.4	-	2.4
Total Demand	195.0	720.7	-	-	3.9	-	47.2	782.7	1,137.9	2,887.5
Unmet Requirements (Waste)	-	0.0	-	-	0.0	-	-	0.0	0.0	0.0

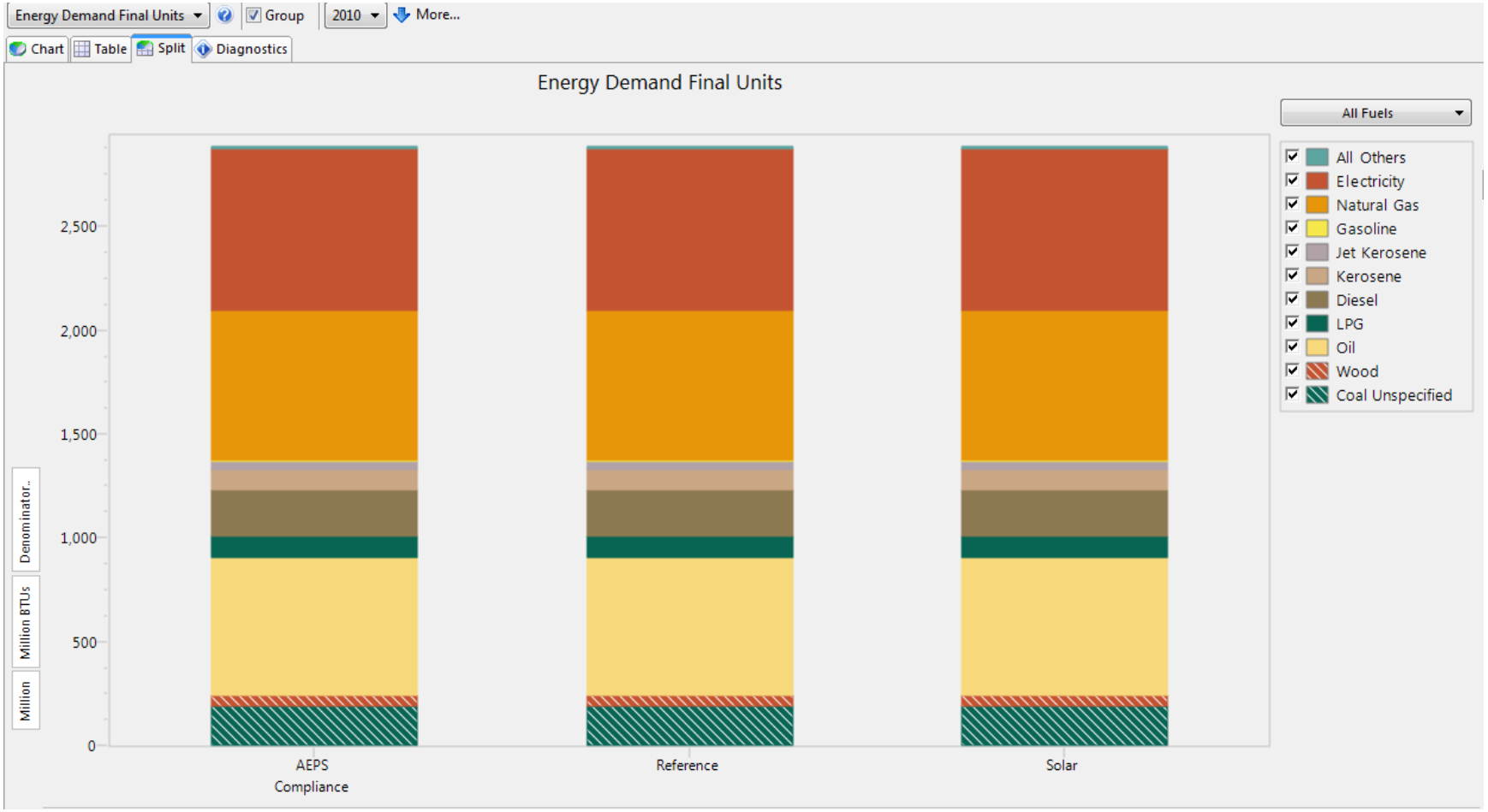
Current Accounts/Supply Demand Balance



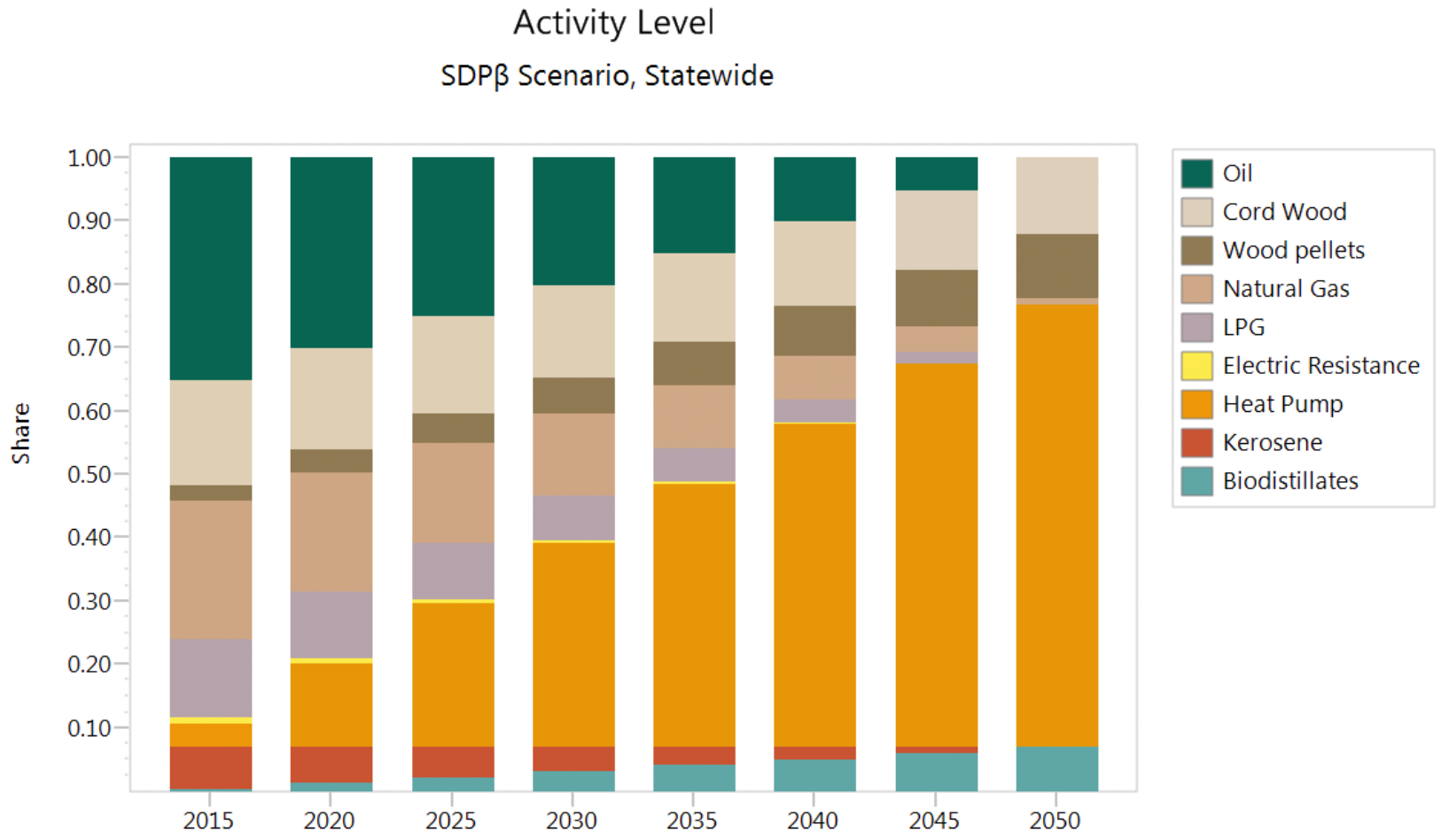
Final Demand, by Sector, Scenario, and Year



Final Demand, by Fuel, Scenario, and Year



Changes in End Use Shares over time VT Example



Key Questions for All Scenarios

- Current market conditions – market share, growth, costs, performance
- Baseline changes, path(s) to meet *Solar Future* target
- Initial Solar scenario
  1. Key interactions / opportunities with more advanced solar deployment
  2. Key regulatory, market, technical, or policy barriers / drivers

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Looking Forward and Next Steps

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For June Meeting

- Identify key data sources and questions
- Review reference scenario
- Initial Solar Future scenario
- Discussion breakouts by strategic focus areas
- Economic and integration impacts will be presented at fall meetings

Outcomes by Year

- 2017: Stakeholder Engagement and Scenario Modeling, Draft PA Solar Future Report
- 2018: Revised PA Solar Future Report and Public Release
- 2019: Dissemination, outreach and implementation support

Thank You!

Discussion & Questions

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