Asia-Pacific Economic Cooperation

APERC Asia Pacific Energy Research Centre

2. Progress report on the APEC Energy Outlook 8th edition

APERC Workshop, Surabaya, Indonesia

16 March 2020

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1. APEC Energy Demand and Supply Outlook, 7th edition roadshow

Roadshow is complete

- Statistics:
  - 21 economies
  - 6 months
  - 507,000 kms traveled
  - 32 tonnes of CO_2 emitted
  - 150 books distributed
  - 698 USBs distributed

Lessons learned from the roadshow

- Outlook is important to economies without forecasting capability
- Some economies would like to use the APERC forecasting model
- Many economies want to keep the format of the publication the same
- We need to learn to use tweets, podcasts and other social media, as well as traditional media, for outreach
- Broadening the roadshow audience to industry and environmentalists builds support for policy changes

2. 8th edition of the APEC Energy Demand and Supply Outlook

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Four more economy reviews are planned

	Q4 2019	Q1 2020	Q2	Q3	Q4	Q1/2 2021	Q3	Q4	Q1 2022	Q2
Economy review of scenarios	**X**									
Model development & assumptions	X	X	X							
Economy review of assumptions			**X**							
Model runs			X	X	X					
Economy and expert review of model results					**X**					
Model runs to respond to comments					X	X	X			
Outlines, chapter drafts, editing					X	X	X			
Economy and expert review of chapters							**X**			
Final drafting								X	X	
Endorsement									X	
Economy review of publication										**X 6**

8th edition scenarios – sent for feedback

Current Policies	Announced Policies	Climate Change
This scenario shows a continuation of **current trends and policies in effect** without any additional policy interventions. It serves as a **reference** for the two alternative scenarios.	This scenario includes current and **announced** policies that have not been implemented, and **targets and goals**.	This scenario presents a decarbonization pathway consistent with a **2 degrees Celsius** future under the Paris Agreement. It identifies the **additional level of ambition and policy packages** to transition to a low-carbon energy system.

Notes: all scenarios use a base year of 2019. Projections are annual through 2050. Macro-economic assumptions are constant across scenarios. Specifics of each scenario are under deliberation.

Current policies are those that are active in law, regulation, and/or implementation. Current policies do not include targets, goals, or other policy proposals that may have been announced but implemented.

Announced policies include targets and goals, and policies that are not yet under implementation. NDCs are included.

Additional policies, technologies, and measures will be introduced in the *Climate Change* scenario, including the possibility of an APEC-wide carbon budget.

8th edition scenarios – feedback

#	Comment	Response
1	How will announced policies be defined?	Policies will be defined on an economy-by-economy basis. A full list of included policies and their representation in the model will be published as part of the Outlook.
2	Where do the APEC targets fit in the scenarios?	Not specifically modeled, however, the Outlook will report energy intensity (FED/GDP & TPES/GDP) and carbon intensity (tons CO_2/FED) for each scenario.
3	It would be useful to see a carbon trading scheme linked to a 2DC or 1.5C scenario.	We are considering a time-varying carbon cap as way to explore these points.
4	Will NDCs and net-zero targets be taken at face value?	We will assume they are feasible.

8th edition scenarios – feedback

#	Comment	Response
5	How will investments be estimated? Will there be sensitivity to cost assumptions?	We use capital costs for investing in new technology in most sectors. Capital costs are a direct model input in this edition. Some costs might differ based on scenario, or possibly performed as a sensitivity analysis. Outlook will include discussion on projected investment needs in an economy's context.
6	Will APERC discuss trade-offs between affordability and sustainability?	A summary table will be added to the Outlook to compare key indicators across the scenarios. Tradeoffs will be discussed.

Assumptions and data collection

- Next economy feedback scheduled for June 2020
- Focus will be input data and assumptions for the modeling
- Assumptions package will contain:

1. Data sheets for model inputs
   - Capital costs by technology
   - Efficiencies and heat rates
   - GDP, population, and global fuel price assumptions

2. Policy List:
   - Economy policies to be considered in the analysis
   - Scenario definitions including the policies

Model development is in progress

- Entire model structure is being redeveloped with aim of improving results and accessibility (for APERC researchers and others)
- Using EGEDA energy balance data (instead of IEA)
- Model uses open-source packages and technologies like Python and OSeMOSYS
- Consistent methodologies adopted across all sectors
- All sectors will have a linear programming (LP) component, enabling model to converge based on price
- Demand sector models leverage machine learning (ML) techniques for making predictions
- Model will be used for training (later this year) and made available for download to economies and the public
- Expect preliminary results by November

Demand sector updates for 8th edition

Sector	Change/update
Agriculture	Uses ML to predict energy demand
Buildings	Residential and services sub-sectors now use same methodology: • Uses ML to predict energy demand • Cost-driven optimization for technology choices using cost and stock databases
Industry	• Uses ML to predict future production (e.g., steel, cement) • Cost-driven optimization for technology choices using cost and stock databases
Transport	• Completely rewritten • Land-based modes: uses ML to predict future service demands: passenger-km and ton-km • Marine & air modes: uses ML to predict energy demand • Cost-driven optimization for technology choices using cost and stock databases
Hydrogen	• No longer a dedicated model • Technology will appear in appropriate sectors

Transformation sector updates for 8th edition

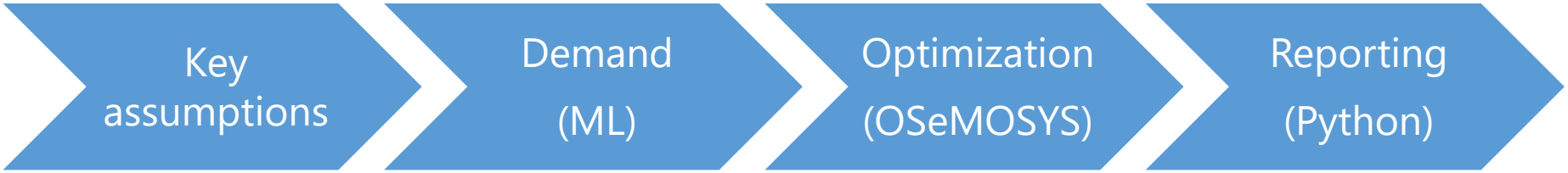
Sector	Change/update
Power	• Redeveloped using OSeMOSYS framework (LP) • Updating technology and performance databases • Reviewing number of technologies and load steps
Refining	• Includes fossil and bio-refining processes • Redeveloped as a LP using OSeMOSYS • Refining output determined by price • Updating capital costs and efficiencies for processes

Supply sector updates for 8th edition

Sector	Change/update
Production (fossil fuels)	• Redeveloped using OSeMOSYS framework (LP) • Creating resource supply curves by economy • Production determined by price
Bio-energy	• Uses ML to predict crop production potential

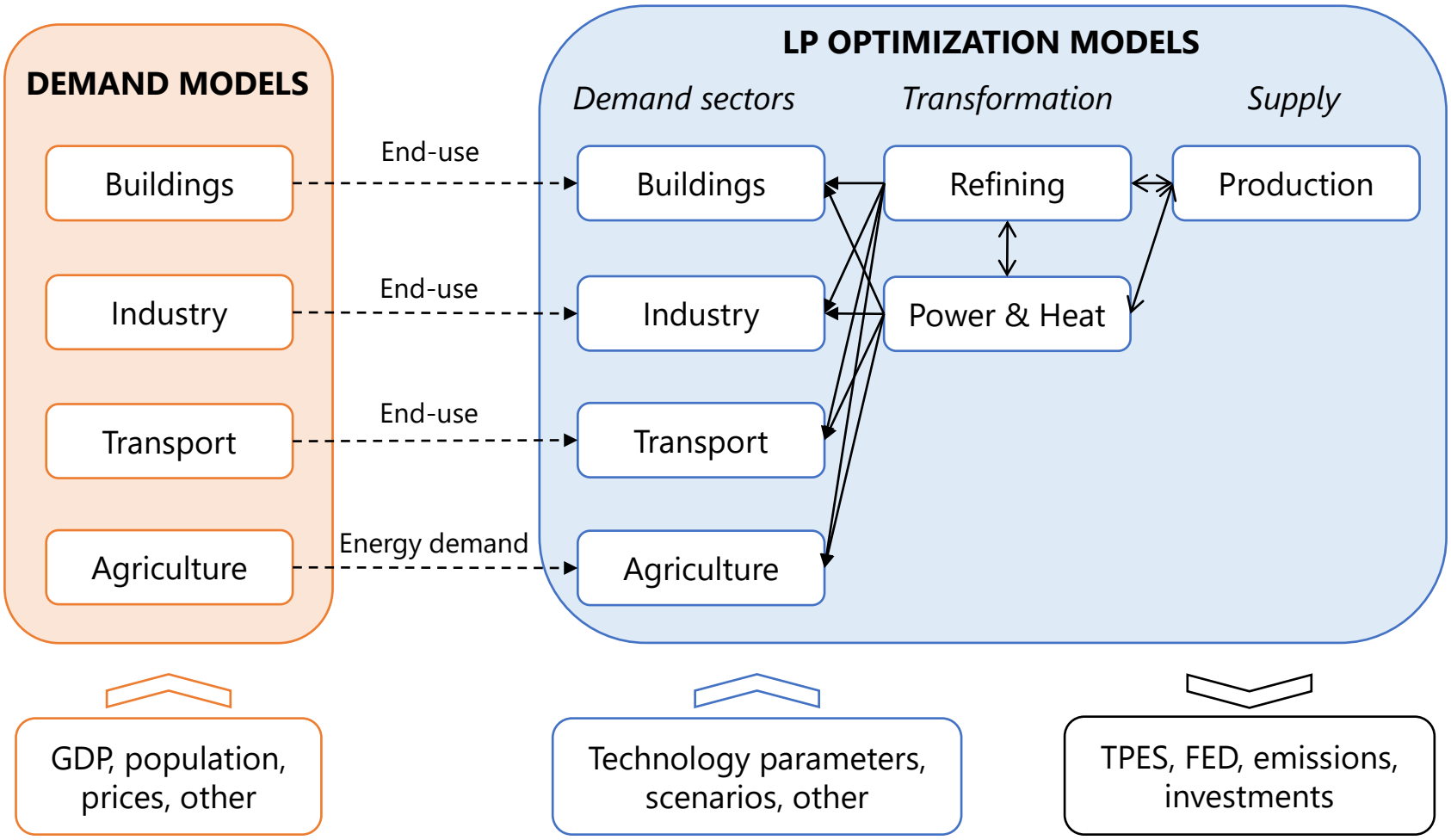
Modeling pipeline for 8th edition

- 7th edition used an Integration Module written in GAMS
- 8th edition adopts a simplified data analysis and modeling pipeline to improve consistency and reduce redundancy



- 8th edition leverages OSeMOSYS to coordinate sector inputs and outputs, and generate model results for reporting process
- 8th edition reporting process utilizes Python for manipulating data and chart generation for use during model development and for final report generation.
- The structure enables use as an online dashboard and in Excel workbooks.

8th edition model will converge on prices

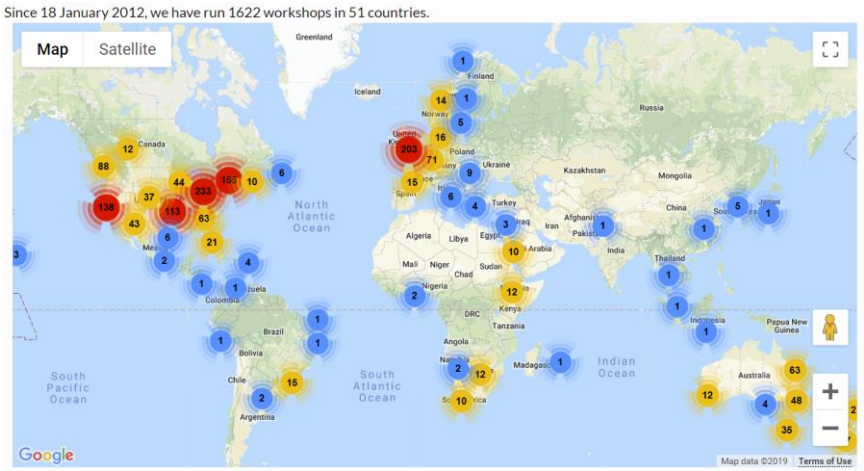


Notes: Demand models project future end-use demand (e.g., lighting). The Agriculture sector projects energy consumption directly due to data limitations.

Notes: Each sector is formulated as an LP. Technology investments and fuel consumption are determined on a least-cost basis, as appropriate. Hydrogen production and consumption is accounted for in individual sectors. Production and Refining contain bio-energy.

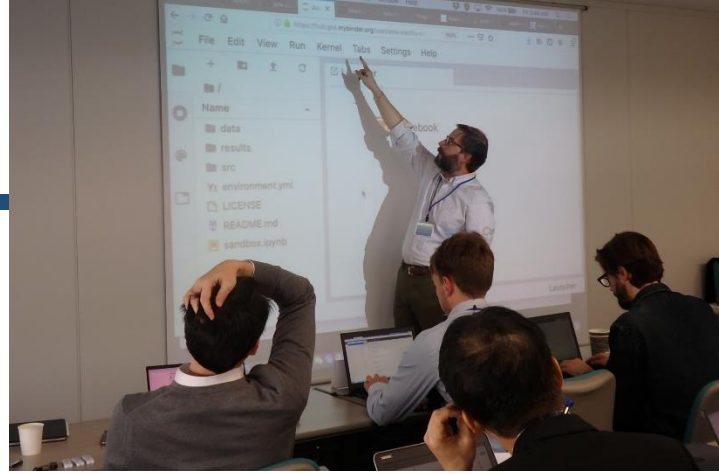
Data analysis training

- APERC hosted the *first – and only* - Software Carpentry training course in Japan
- 15 APERC researchers participated and received Completion Certificates
- 11-19 November 2019
- Course syllabus:
  - Introduction to Shell
  - Introduction to version control using Git
  - Introduction to Conda and Jupyter Lab
  - Introduction to programming in Python
  - Introduction to Pandas and Matplotlib
  - Python functions
  - Advanced Python topics
  - Introduction to Sci-kit Learn
  - In-class exercise: forecasting residential energy demand in APEC



- Course material is available online at https://davidrpugh.github.io/2019-11-11-aperc/

Data analysis training



Thank you for your kind attention

https://aperc.ieej.or.jp/

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