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Managing the Energy Trilemma in the Philippines

Josef T. Yap, Aaron Joseph P. Gabriola and Chrysogonus F. Herrera

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- My co-authors (AJ and Chrys)
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- EU, for supporting the ASEP-CELLs project

What is the Energy Trilemma?

Figure 3: The Trilemma dimensions

ENERGY SECURITY

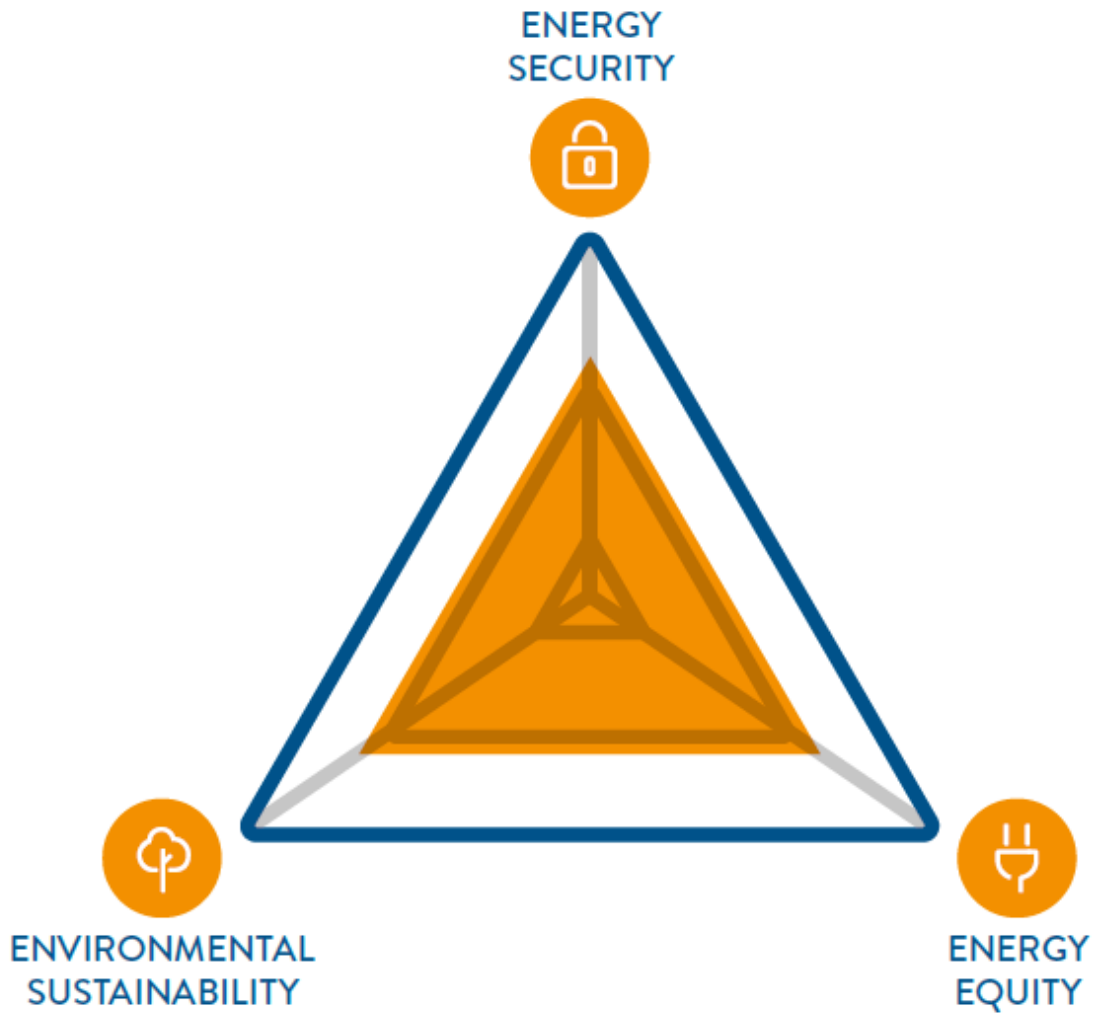
Reflects a nation's capacity to meet current and future energy demand reliably, withstand and bounce back swiftly from system shocks with minimal disruption to supplies.

ENERGY EQUITY

Assesses a country's ability to provide universal access to affordable, fairly priced and abundant energy for domestic and commercial use.

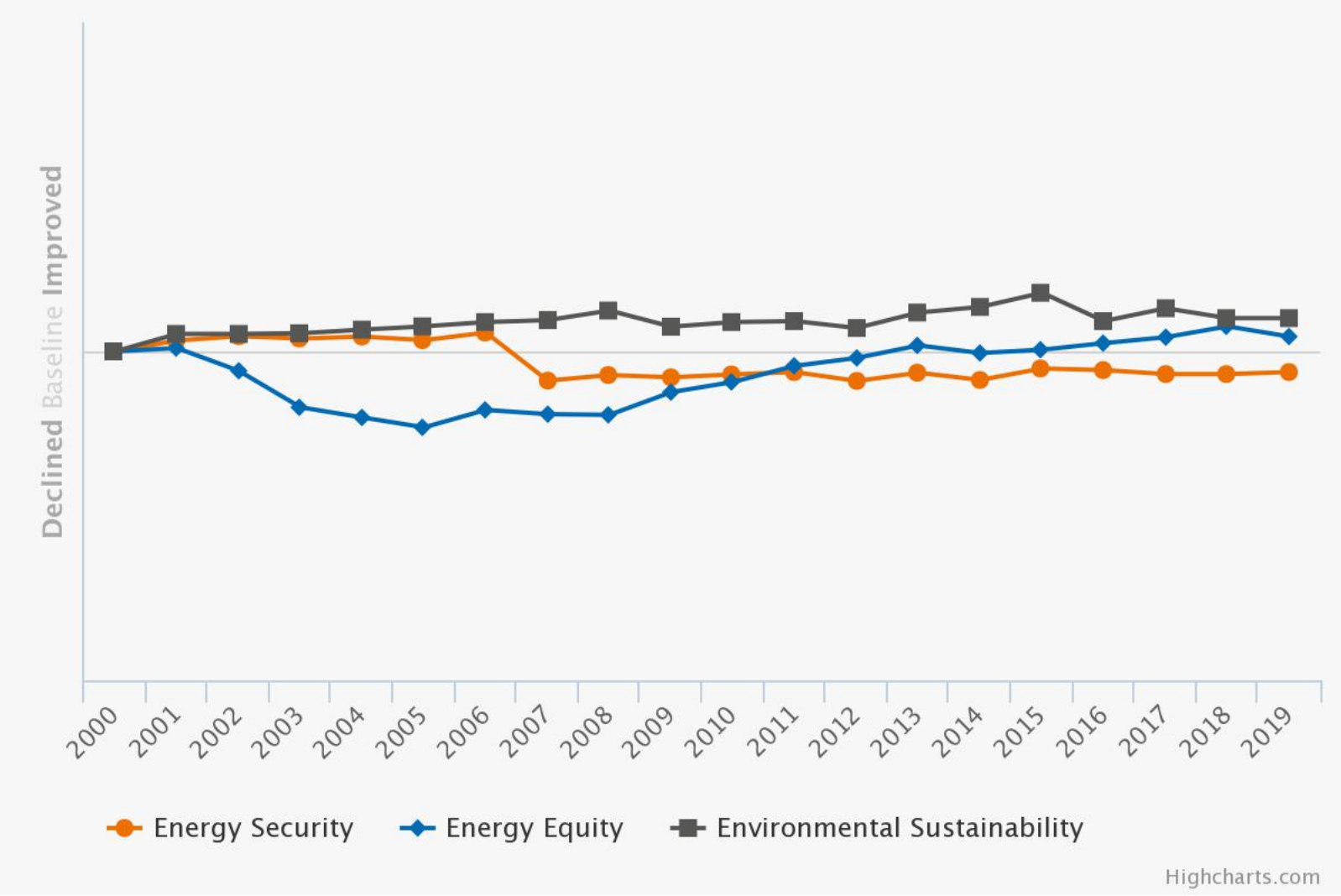
ENVIRONMENTAL SUSTAINABILITY OF ENERGY SYSTEMS

Represents the transition of a country's energy system towards mitigating and avoiding potential environmental harm and climate change impacts.



Source: World Energy Council. 2019 World Energy Trilemma Index

Energy trilemma in the Philippines, World Energy Council framework (PH is 94th out of 128 in managing trilemma)



Contribution of ASEP-CELLs

- Sharpen the framework of trade-offs and synergies
- Dealing with components of Energy Security as defined by IEA:
  - **Autarky** (self-sufficiency)
  - **Price** (relates to affordability, indirectly to accessibility)
  - **Supply**
  - **Sustainability** (measured by carbon emissions)
- Manage the Trilemma by providing a mechanism to evaluate policy options

- NOTE: Supply is proxied by the Capacity Reserve Margin = (Total generation capacity – peak load) / peak load %

Framework: Welfare Function

- Welfare Function: $\boldsymbol{W = AT^{\alpha} P^{\beta} S^{\gamma} C^{\delta}}$
- Different policy options yield different values of AT, P, S and C and therefore different values of W
- Choose policy option that yields highest W
- Problem: How to determine the parameters α, β, ϒ, δ?
- Answer: Revealed preference of the DoE Secretary, apply Multi-Criteria Decision Making (MCDM) e.g. the Analytical Hierarchy Process

Example

	α	β	ϒ	δ
Secretary 1	0.42	0.12	0.28	0.18
Secretary 2	0.25	0.25	0.25	0.25

$$W = AT^{\alpha}\left(\frac{1}{P}\right)^{\beta} S^{\gamma}\left(\frac{1}{C}\right)^{\delta}$$

Relevant Welfare Function

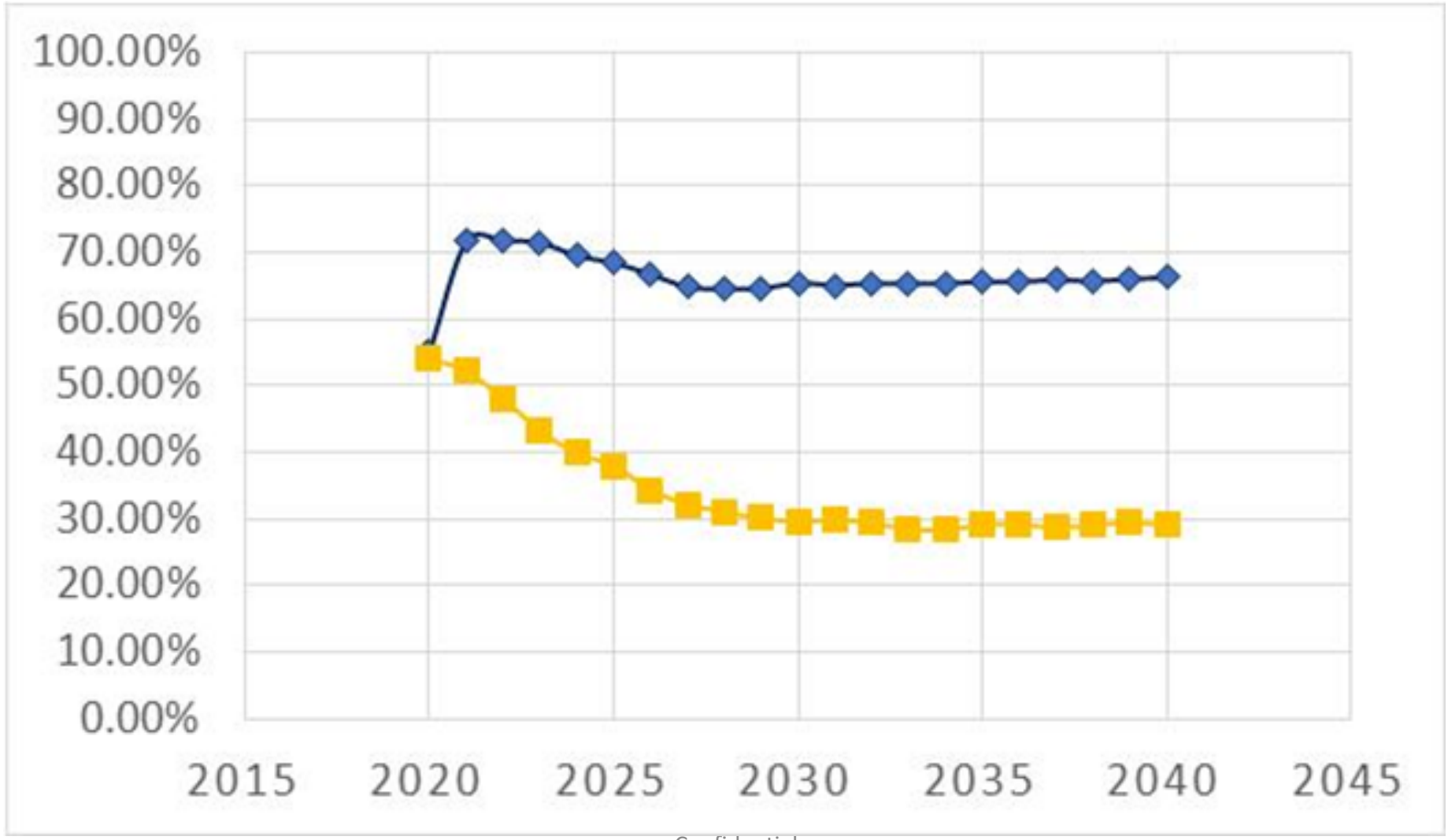
Generate values of the key variables (AT, P, S, C)

For this study, PLEXOS Software is used; the model incorporates trade-offs and synergies

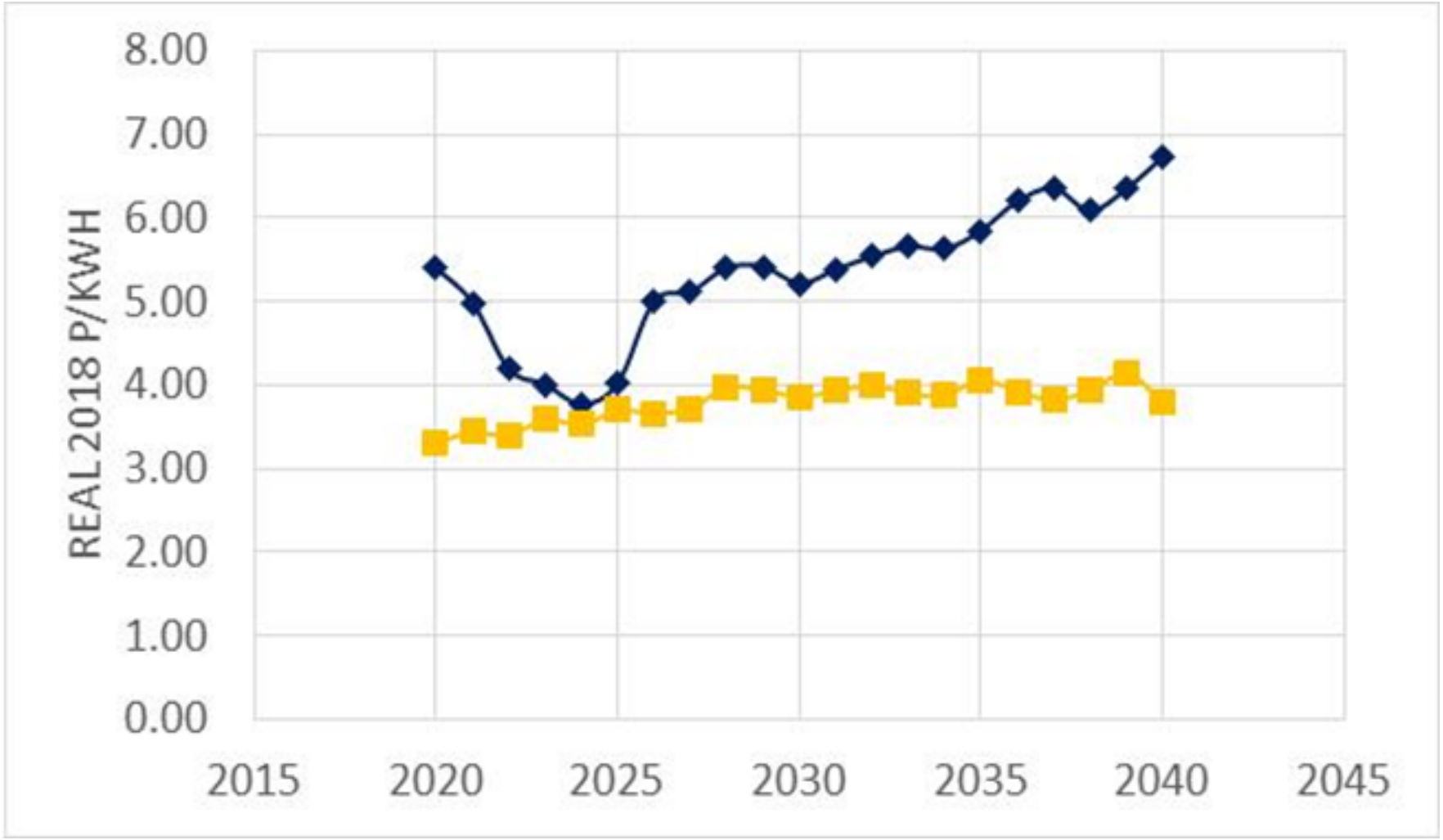
Time horizon: 2020-2040

Note: In the charts, yellow is the baseline

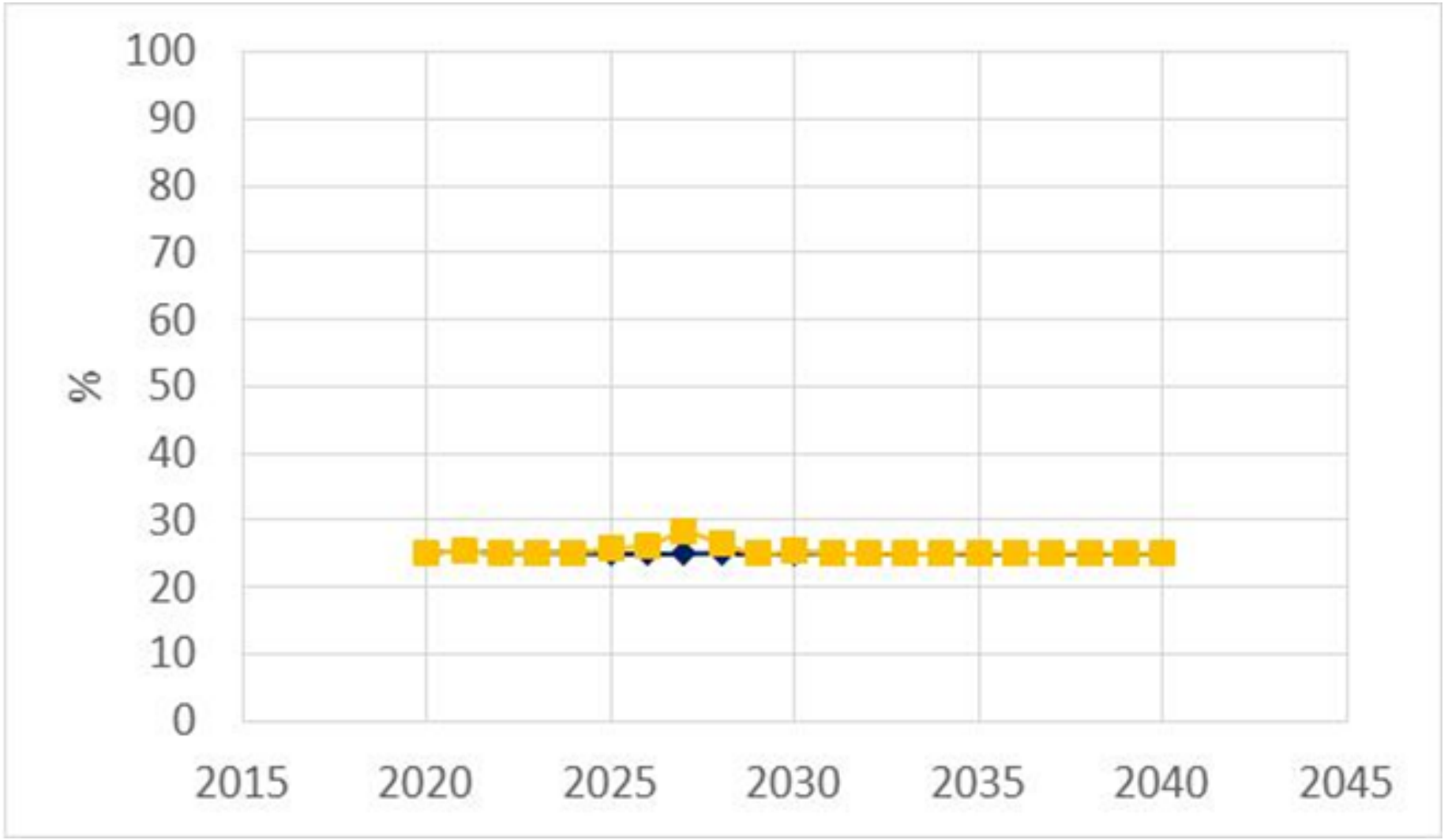
Impact of Carbon Tax (100% SCC) on Autarky Levels



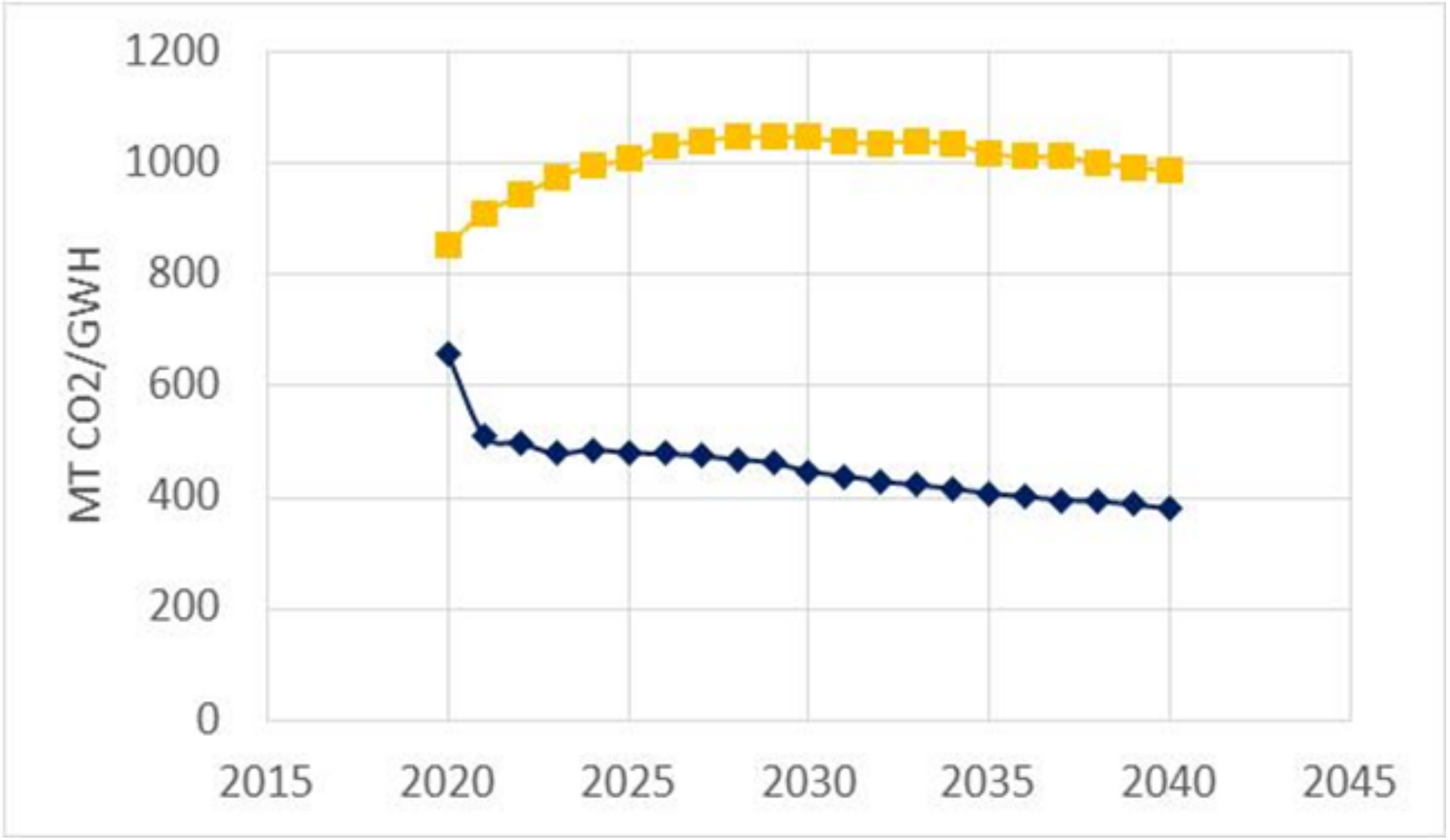
Impact of Carbon Tax (100% SCC) on Price P/kWh



Impact of Carbon Tax (100% SCC) on Capacity Reserve Margin %



Impact of Carbon Tax (100% SCC) on Carbon Intensity $MTCO_2/GWh$



Comparison of Welfare for Market-based and Carbon tax scenario

	α	β	ϒ	δ
Secretary 1	0.42	0.12	0.28	0.18
Secretary 2	0.25	0.25	0.25	0.25
Secretary 3	0	1	0	0

	Market Based Scenario	Scenario with Carbon Tax
Secretary 1	0.0832	0.2362
Secretary 2	0.0912	0.2230
Secretary 3	0.6892	0.2791

How are the weights of Secretary 3 obtained?

Answer: These are the weights that maximize welfare under market based scenario: $\alpha^*, \beta^*, \gamma^*, \delta^*$ (obtained through simulation−based optimization)

Secretary 1 and Secretary 2 will impose the carbon tax. Secretary 3 will not.

Do the results indicate that Secretary 3 should head the DoE?

Answer: Not at all. Straightforward to imagine a scenario with another set of parameters and values of the variables that yield a higher W.

The parameters are generally decided by preferences of society. The welfare function is a mechanism to rank different polices (given the parameters)

Note: What the results indicate is that if society prefers a market based approach then the optimum set of parameters is $\alpha=\delta=\Upsilon=0$ and $\beta = 1$.

Future Direction of Research

- Given parameters of W, what would be the values of AT, P, S and C to maximize W? What policy variables can be adjusted to get these optimal values?
- Incorporate accessibility directly
- Link the simulation model to economic variables such as GDP and poverty incidence to obtain a more comprehensive welfare function
- Demonstrate how greater energy efficiency will improve all components of energy security

감사합니다

Maraming Salamat!!!

Terima Kasih

ขอบคุณครับ

ありがとう

धन्यवाद

Cảm ơn rất nhiều

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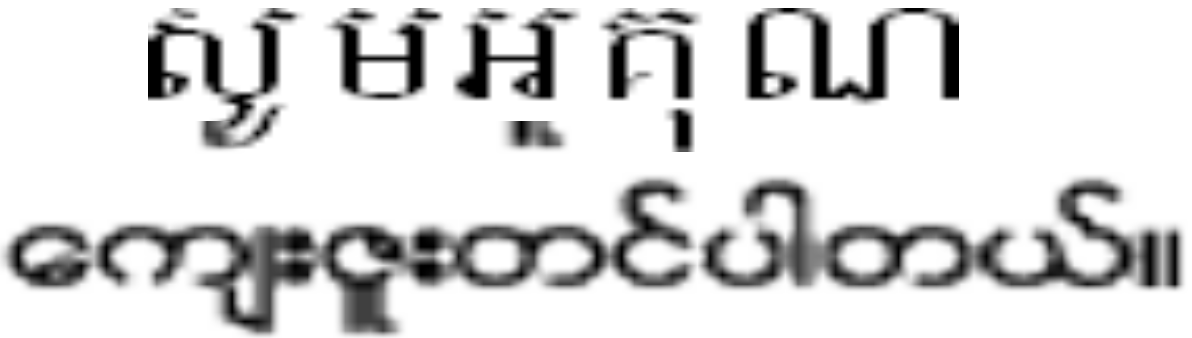
謝謝你。



THANK YOU !!!