

SOLUCIONES ENERGÉTICAS PARA TRANSFORMAR A PUERTO RICO

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# Plan Integrado de Recursos (PIR 2024)

[Enero 2024]



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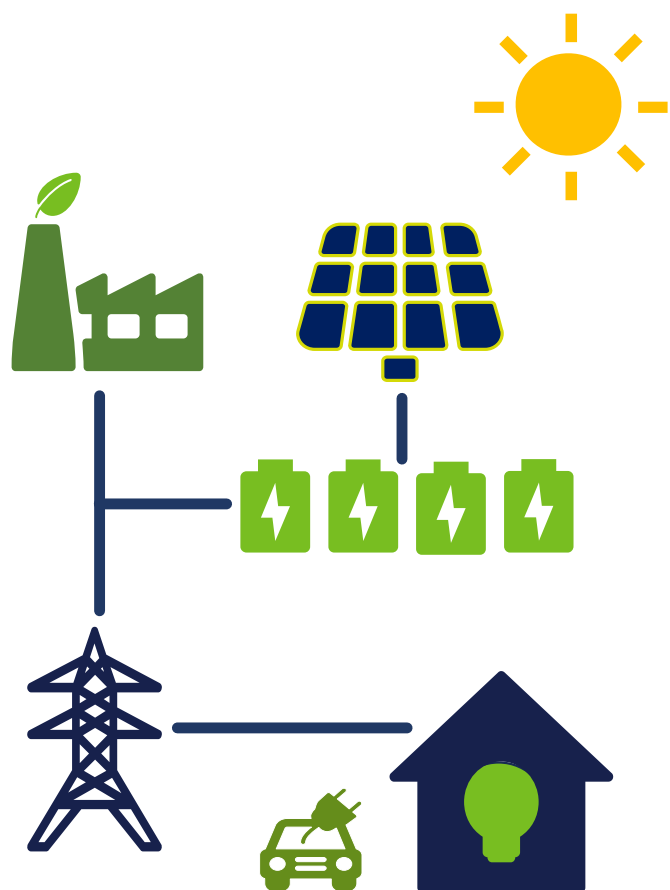
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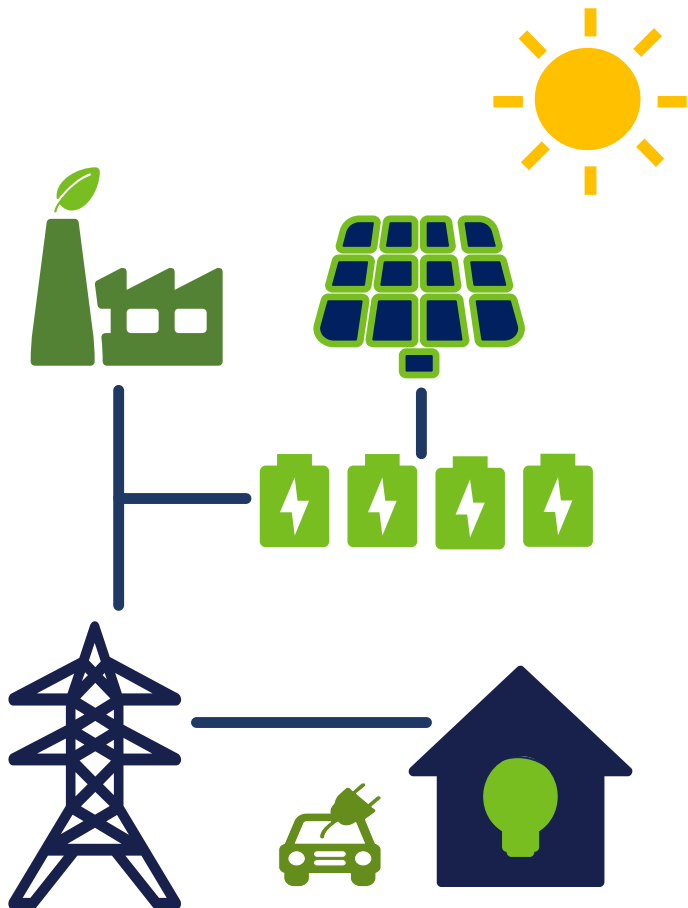
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## El PIR de Puerto Rico

El éxito del PIR 2024 depende de la colaboración y la aportación de partes interesadas.

Tus ideas y recomendaciones aportarán al desarrollo del PIR 2024.



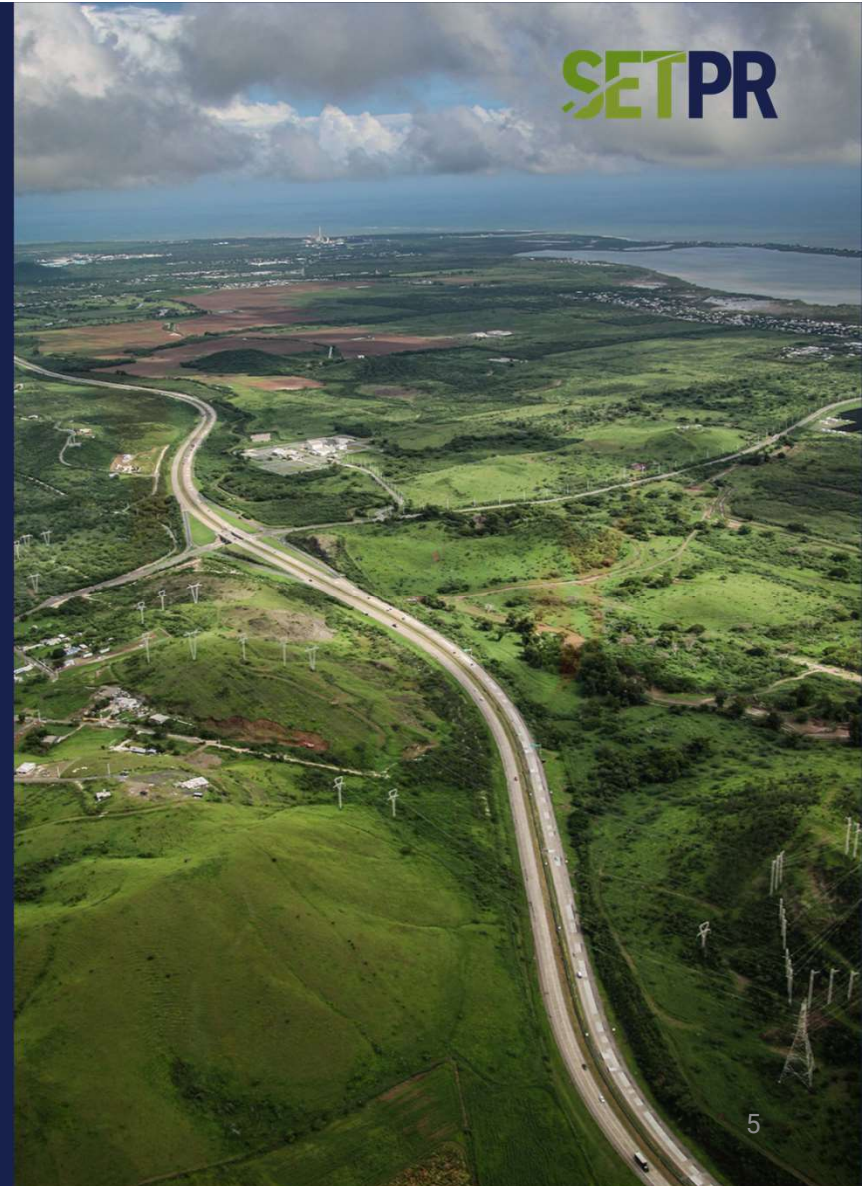
## It's Puerto Rico's IRP

The success of the 2024 IRP depends on the collaboration with Stakeholders.

Your feedback and recommendations will help create a better 2024 IRP for Puerto Rico.

# Agenda

- Consultor Técnico / Technical Consultant (Black & Veatch)
- Resumen del PIR y Taller SETPR / Update of SETPR and Workshops
- Objetivos / Objectives
- Escenarios / Scenarios
- Preguntas y respuestas / Q&A
- Introducción al enfoque de modelaje en PLEXOS / Intro to PLEXOS modeling
- Preguntas y respuestas / Q&A



## **Black & Veatch (B&V)**

- B&V fue fundada en el 1915 para ofrecer servicios de ingeniería, adquisiciones, consultoría y construcción.
- Actualmente, B&V es una compañía internacional con más de 100 años de experiencia en innovaciones de infraestructura sostenible, con oficinas en Europa, Asia, África y América.
- Fueron contratados por LUMA para realizar los modelajes de PLEXOS y aportar recomendaciones y soluciones viables para Puerto Rico.

## **Black & Veatch (B&V)**

- B&V was founded in 1915 to provide engineering, procurement, consulting, and construction services.
- Today, B&V is an international company with more than 100 years of experience in sustainable infrastructure innovations, with offices in Europe, Asia, Africa and America.
- They were hired by LUMA to carry out the PLEXOS modeling and provide recommendations and viable solutions for Puerto Rico.

## Experience with IRP Studies

Extensive IRP Experience, Including the Following Island Studies:

- **Kauai Island** (IRP, stakeholder meetings, RE studies)
- **Trinidad and Tobago** (IRP and government scoping meetings)
- **St. Croix, U.S. Virgin Islands** (IRP, stakeholder meetings)
- **St. Thomas, U.S. Virgin Islands** (IRP, stakeholder meetings)
- **St. John, U.S. Virgin Islands** (IRP, stakeholder meetings)
- **Bermuda** (IRP support, capital cost estimates)
- **Jamaica** (IRP support addressing government feedback and frequency control issues)
- **Mississippi, USA** (Cooperative Energy; IRP)
- **Panama City, Panama** (Panama Expansion Plan Modeling)
- **Hong Kong, China** (Desalination and Power Optimization Studies)

**Dozens of other IRP studies for U.S. and International Utilities**



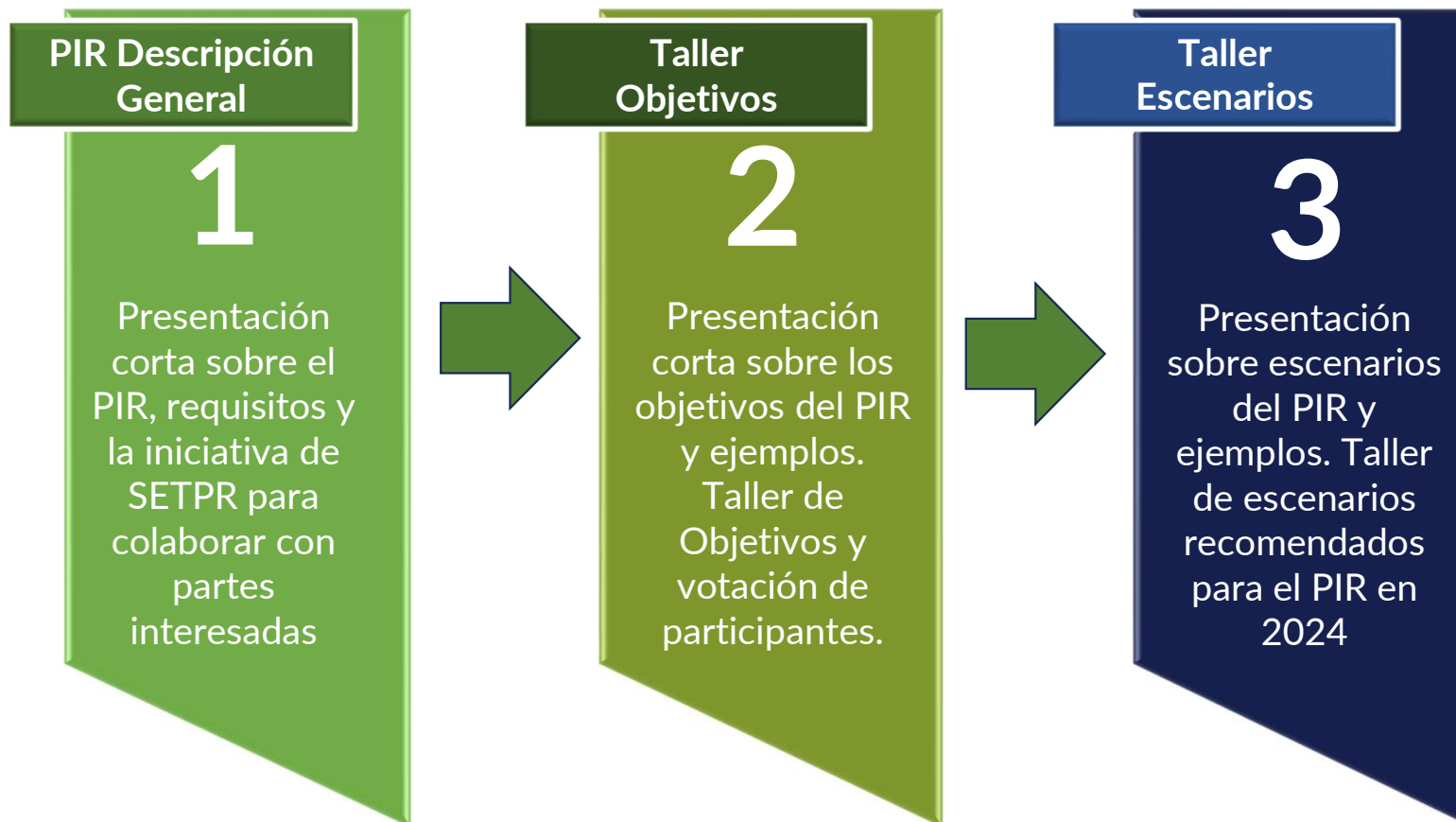
## Black & Veatch IRP Team

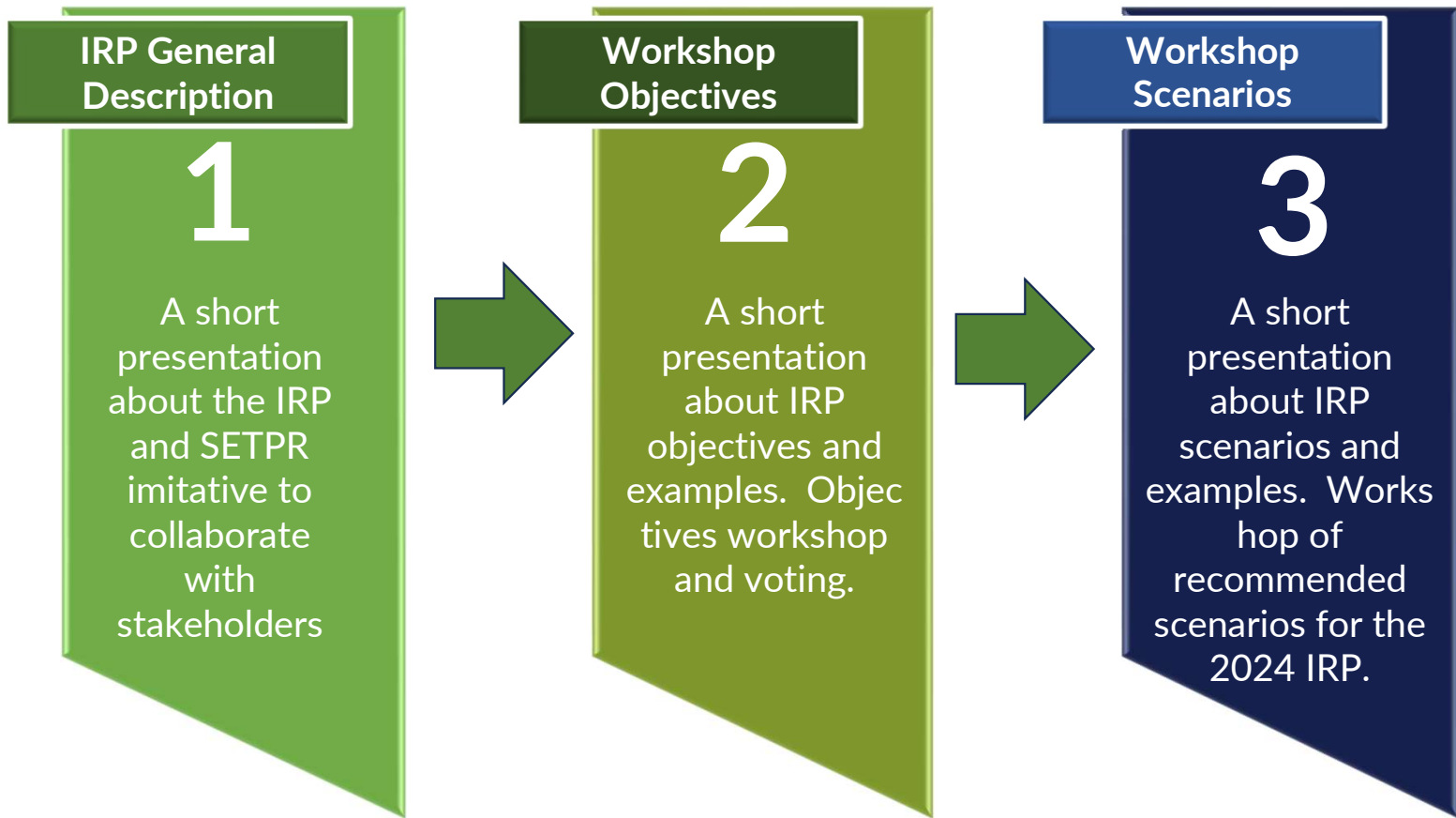
- **Matt Futch:** Project Director for the Puerto Rico IRP; B&V Managing Director; > 20 Years Power Industry Experience; formerly with NREL
- **John Wynne:** Project Manager for the Puerto Rico IRP; B&V Managing Director, 34 Years with B&V – all in system planning, formerly Senior Economist with the Indiana PUC
- **Brian Manley:** PLEXOS Modeler for the Puerto Rico IRP; PE, Senior Energy Market Modeling Consultant, Expert in PLEXOS Expansion Planning Modeling
- **Alankar Sharma:** PLEXOS Modeler for the Puerto Rico IRP; B&V Consultant with extensive experience in IRP studies for islanded systems, with PLEXOS Expansion Planning and Nodal Power Flow Modeling skills

## Reuniones con Partes Interesadas Enero 2024

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
<b>Colegio de Ingenieros y Agrimensores de Puerto Rico (CIAPR)</b>		01	02	03	04	05	06
<b>CIAPR Arcibo 15 de enero del 2024</b>	07	08	09	10	11	12	13
<b>CIAPR Guayama 16 de enero del 2024</b>	14	15	16	17	18	19	20
<b>CIAPR San Juan 17 de enero del 2024</b>	21	22	23	24	25	26	27
<b>CIAPR Mayagüez 18 de enero del 2024</b>	28	29	30				

\*\*Presentación Virtual el [8 de febrero del 2024](#) 10:00 am – 12:00 pm



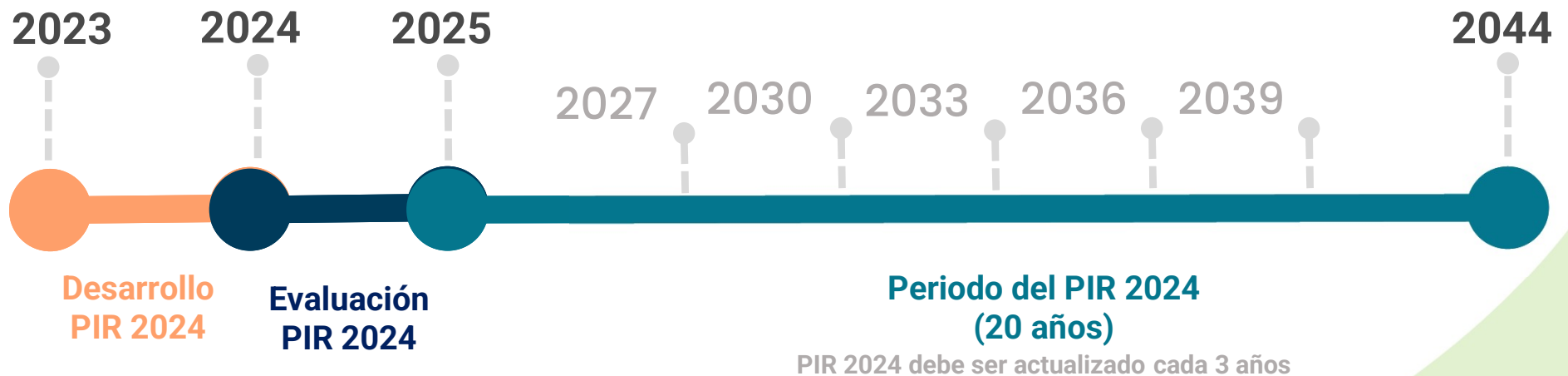


# Resumen del PIR y Talleres



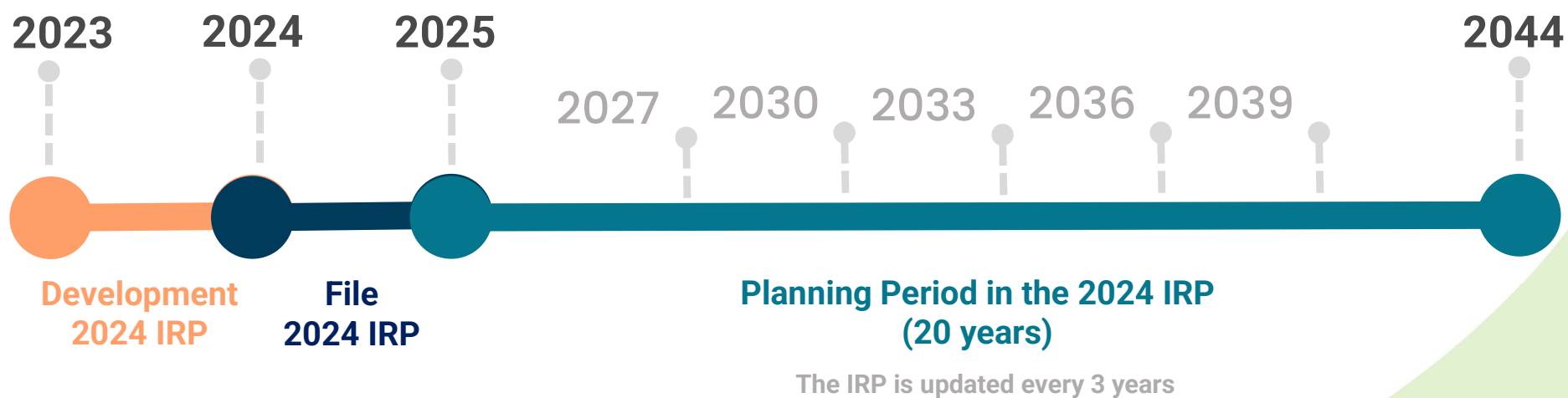
# Resumen del PIR y Talleres

**El PIR es un plan a 20 años para Transformar el Sistema Eléctrico de Puerto Rico**



**El PIR 2024 debe definir los recursos de menor costo que cumplan con las metas de proveer energía confiable, limpia, eficiente, resiliente y asequible para Puerto Rico.**

## 20-year Plan to Transform Puerto Rico's Energy System



**The 2024 IRP must define the lowest-cost resources that meet the goals of providing reliable, clean, efficient, resilient and affordable energy for Puerto Rico.**

**El PIR 2024 debe considerar todos los recursos razonables para satisfacer la demanda de los servicios de energía eléctrica.**



- Evaluar el estado actual del Sistema de Transmisión y Distribución, y generación de PR.
- Considerar el aumento de generación distribuida.
- Estudiar los pronósticos de carga futuros.
- Considerar los costos de nueva generación y almacenamiento de energía.
- Considerar los costos para actualizar el sistema eléctrico para la integración de recursos de energía renovable distribuida y a gran escala.



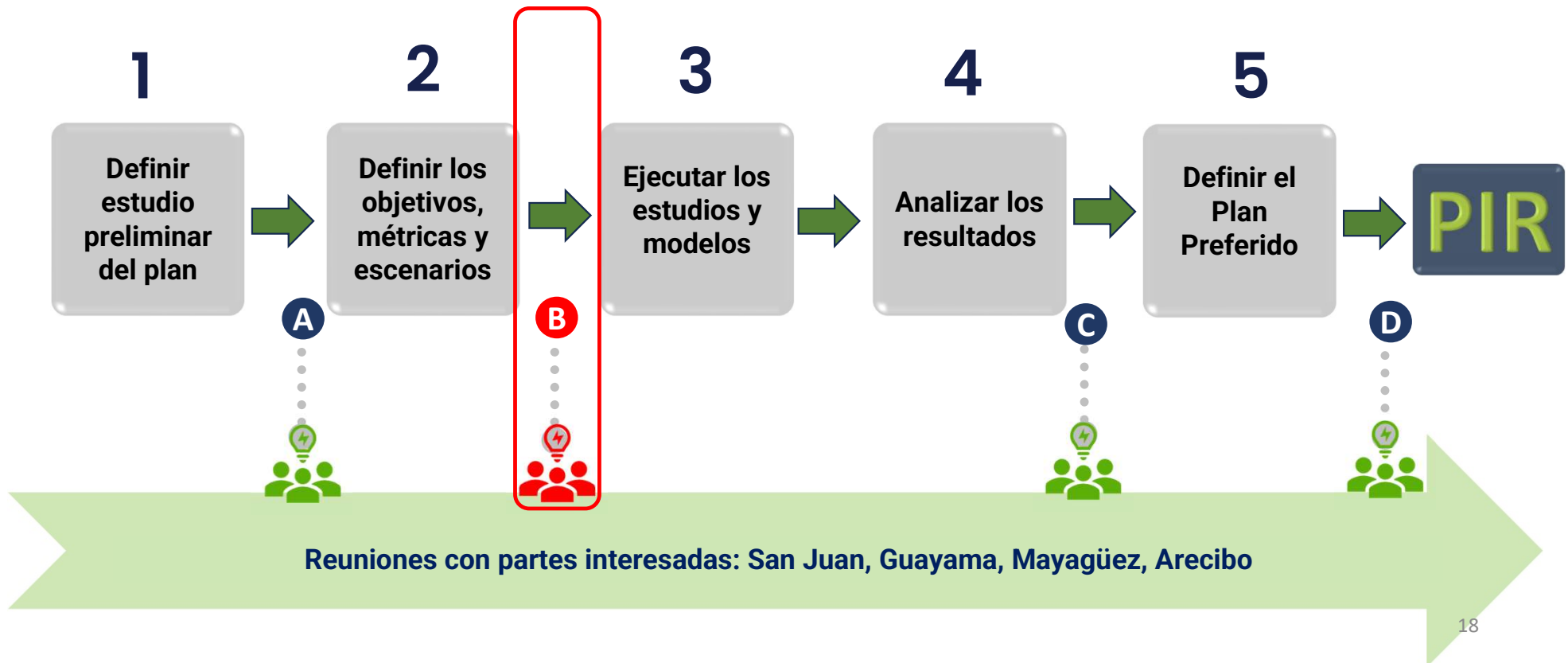
**The 2024 IRP must consider all reasonable resources to meet the demand for electric power services.**



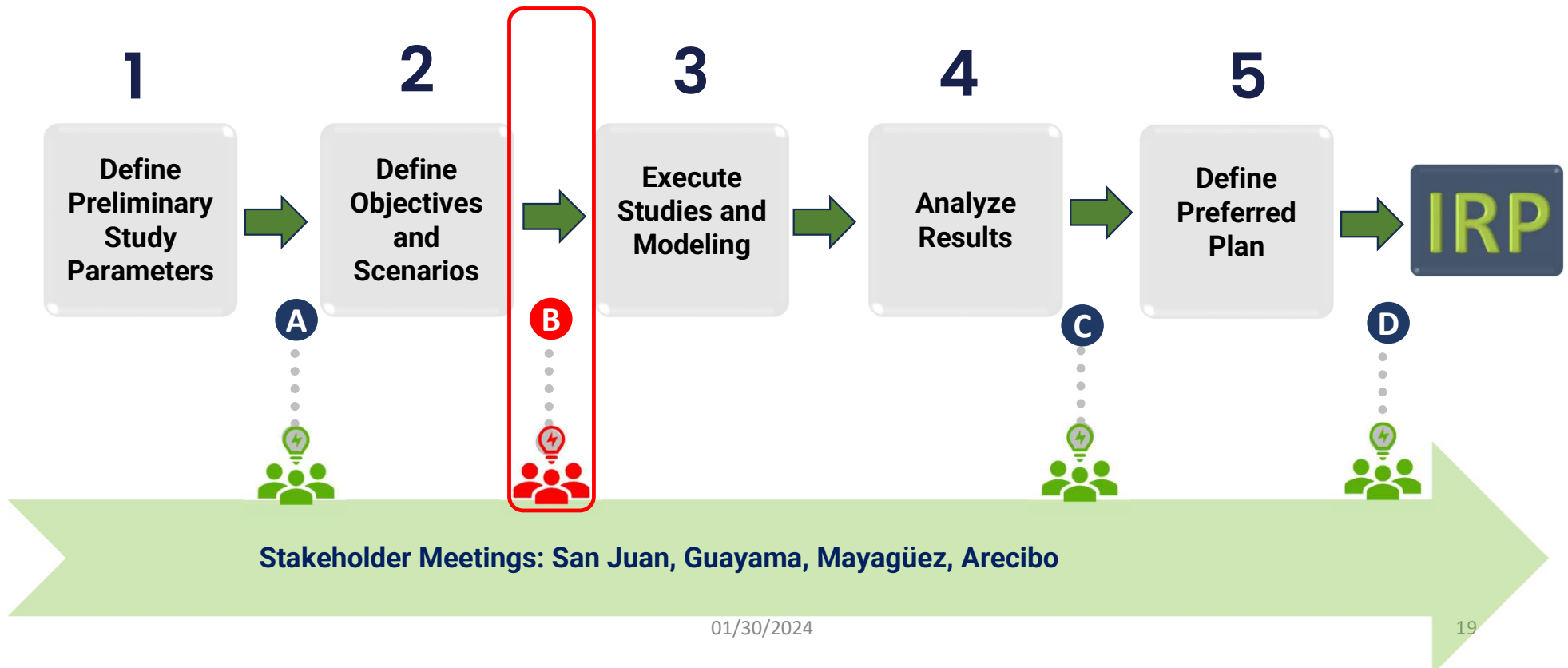
- Consider the existing state of PR's T&D grid and generation
- Consider the costs of new generation and energy storage
- Enable increase of distributed energy resources
- Consider the costs of grid changes to enable distributed and utility-scale renewables
- Analyze customer load forecast

# Resumen del PIR y Talleres

Las partes interesadas serán parte del proceso de desarrollo del PIR 2024 hasta que se radique ante el Negociado de Energía



Stakeholders will be part of the development process until the 2024 IRP is filed with the Energy Bureau



## 140 Participantes / 17 Talleres



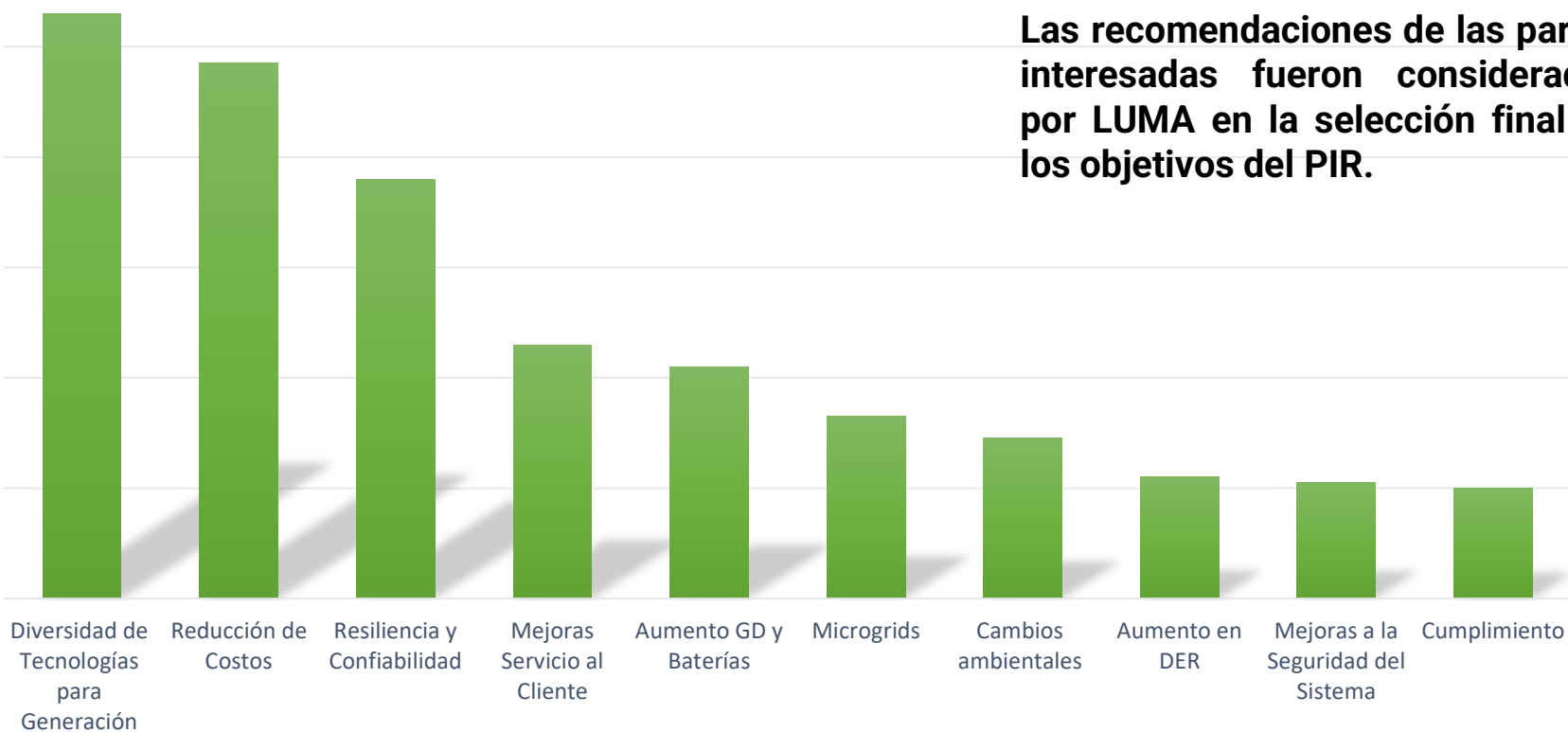
## 140 Participants / 17 Workshops



## Objetivos / Objectives

# Objetivos Recomendados por Partes Interesadas

Resultados Votación



# Objectives recommended by Stakeholders



## Stakeholder's recommendations for Objectives





# Objetivos Recomendados por Partes Interesadas



## Diversidad de Tecnologías para Generación

Las partes interesadas quieren diversidad de tecnologías para generar energía limpia y renovable, desde hidroeléctrica hasta nuclear – no sólo energía solar.

## Aumento en Generación Distribuida y Baterías

Aumento en generación distribuida y baterías para cumplir con el mandato de la Ley 17.



## Reducir Costos

Reducir costos de generación y tarifa eléctrica.

## Mejorar servicio al cliente

Mejorar la comunicación con clientes. Las partes interesadas indicaron que no estaban recibiendo suficiente información sobre LUMA

## Resiliencia y Confiabilidad del Sistema

Mejorar la resiliencia y confiabilidad del sistema para reducir apagones y problemas de voltaje, y reconectar a clientes rápidamente después de un evento de emergencia.

# Objectives recommended by Stakeholders



## Diverse technology

Stakeholders want diverse technologies for the generation of clean and renewable energy, from hydroelectric to nuclear energy – not only solar

## Increase DG & Batteries

Increase the amount of DG and batteries in PR to comply with Act 17

## Reduce Costs

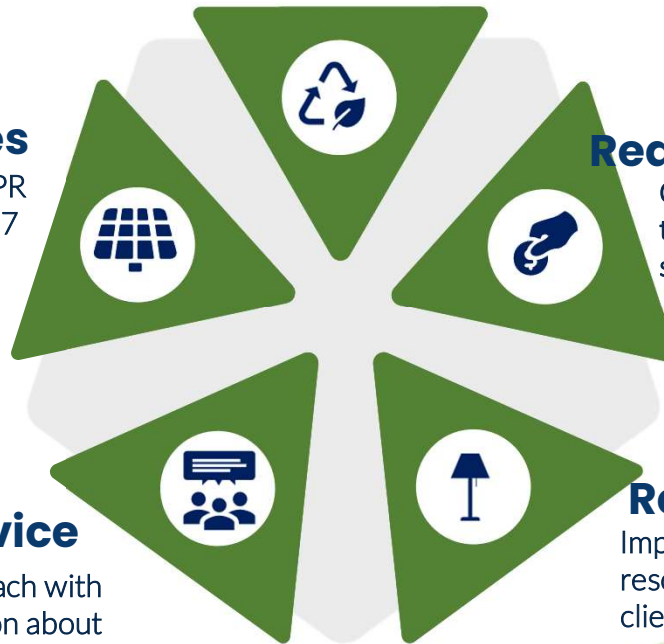
Cost reduction / Rate stability was the second main objective for stakeholders

## Improve Customer Service

Improve communication and outreach with clients; Clients are not receiving information about LUMA

## Reliability and Resiliency

Improve reliability and resiliency of the system to resolve voltage and frequency issues and reconnect clients after a major event



## Objetivos del PIR / IRP Objectives

## Costos

1. Portfolio de menor costo
2. Reducir costos de energía suplida
3. Reducir y estabilizar tarifa del cliente

## Ambiente

1. Reducir emisiones
2. Aumentar energía renovable
3. Mejorar la capacidad del sistema para integrar mayor cantidad de renovables
4. Aumento Vehículos Electricos e infraestructura

## Confiable y Resiliente

1. Maximizar la transmisión de la carga servida por generación
2. Maximizar demanda crítica del Sistema
3. Reparaciones necesarias para estabilizar el Sistema
4. Desarrollo de proyectos nuevos para proveer un servicio confiable y resiliente

## Recursos de Energía Distribuida

1. Facilitar aumento de recursos de energía distribuida
2. Evitar que clientes sin energía distribuida sean afectados.

# Act 17 Objectives



## Costs

1. Least cost Portfolio
2. Reduce nominal costs of energy supply
3. Reduce and stabilize customer's rate

## Environment

1. Reduce emissions
2. Increase renewable energy
3. Improve the capacity of the system to allow greater penetration of renewables
4. Increase EV's and infrastructure

## Reliability and Resiliency

1. Maximize transmission of load served by generation
2. Maximize critical load served by generation
3. Necessary restorations to stabilize the system.
4. Develop new projects to provide reliable service to customers during and after emergencies.

## Distributed Energy Resources

1. Enable distributed energy resources growth
2. Customers without distributed energy should not be impacted

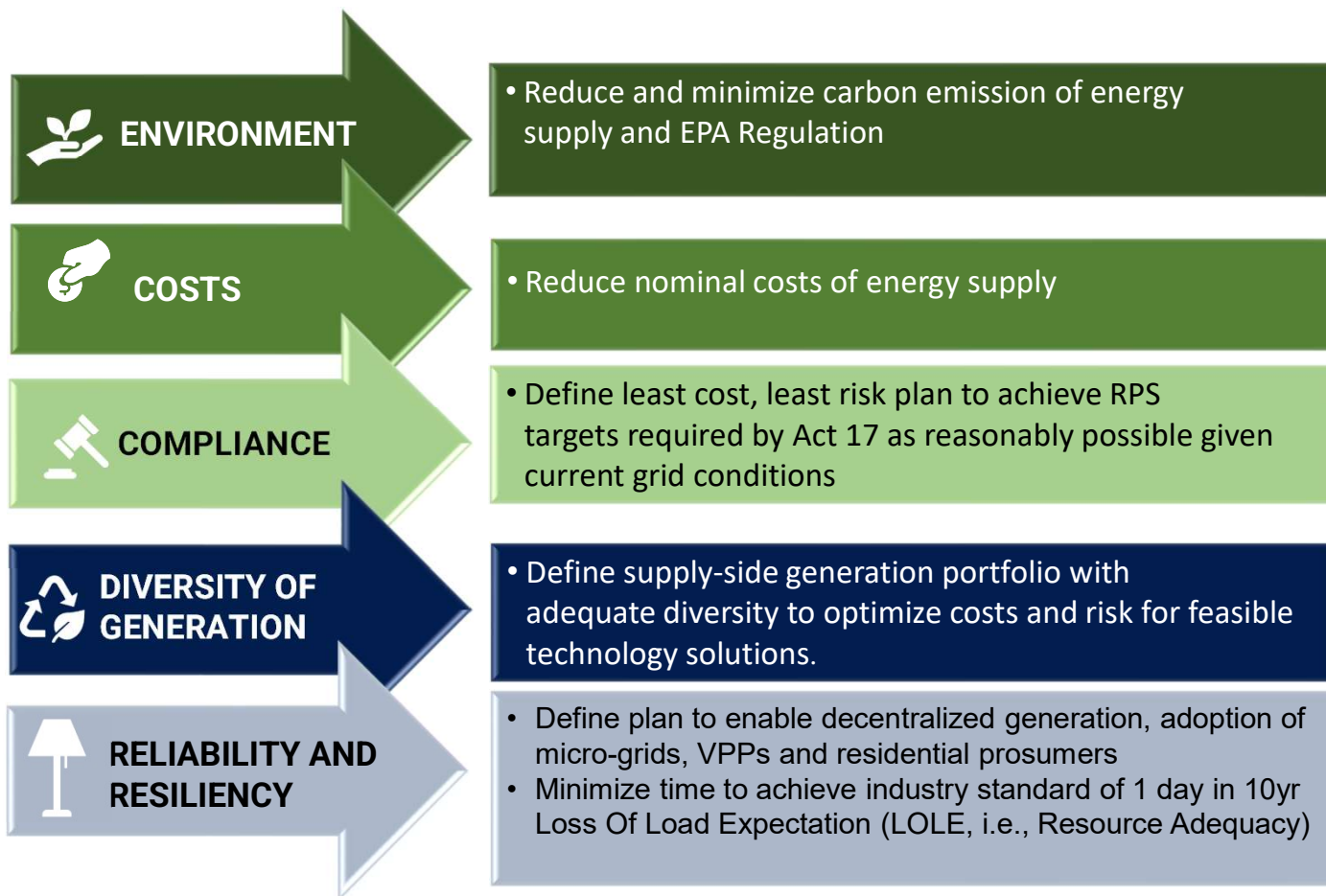
# Objetivos del PIR 2024



## Indicadores adicionales a seguir que no se consideran objetivos

- Acres de tierra utilizados % de energía de DER
- Número de tecnologías analizadas

# Objetivos del PIR 2024



### Additional Indicators to be tracked that are not considered objective

- Acres of land used % of energy from DER
- Number of technologies screened

## Escenarios / Scenarios

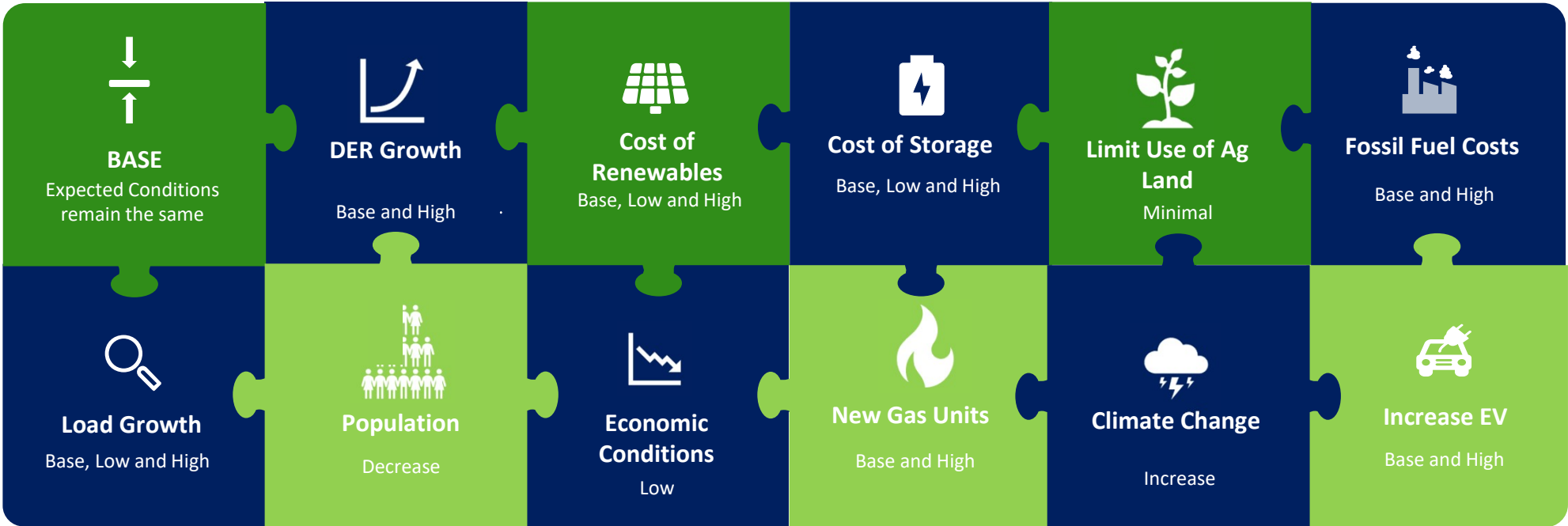


# Características de los Escenarios Recomendados por las Partes Interesadas



Las recomendaciones de las partes interesadas fueron consideradas por LUMA en la selección final de los escenarios del PIR.

# Characteristics of Scenarios recommended by Stakeholders











Stakeholder recommendations were considered in the final selection of the 2024 Scenarios

# Escenarios del PIR / IPR Scenarios

# Escenarios del PIR 2024

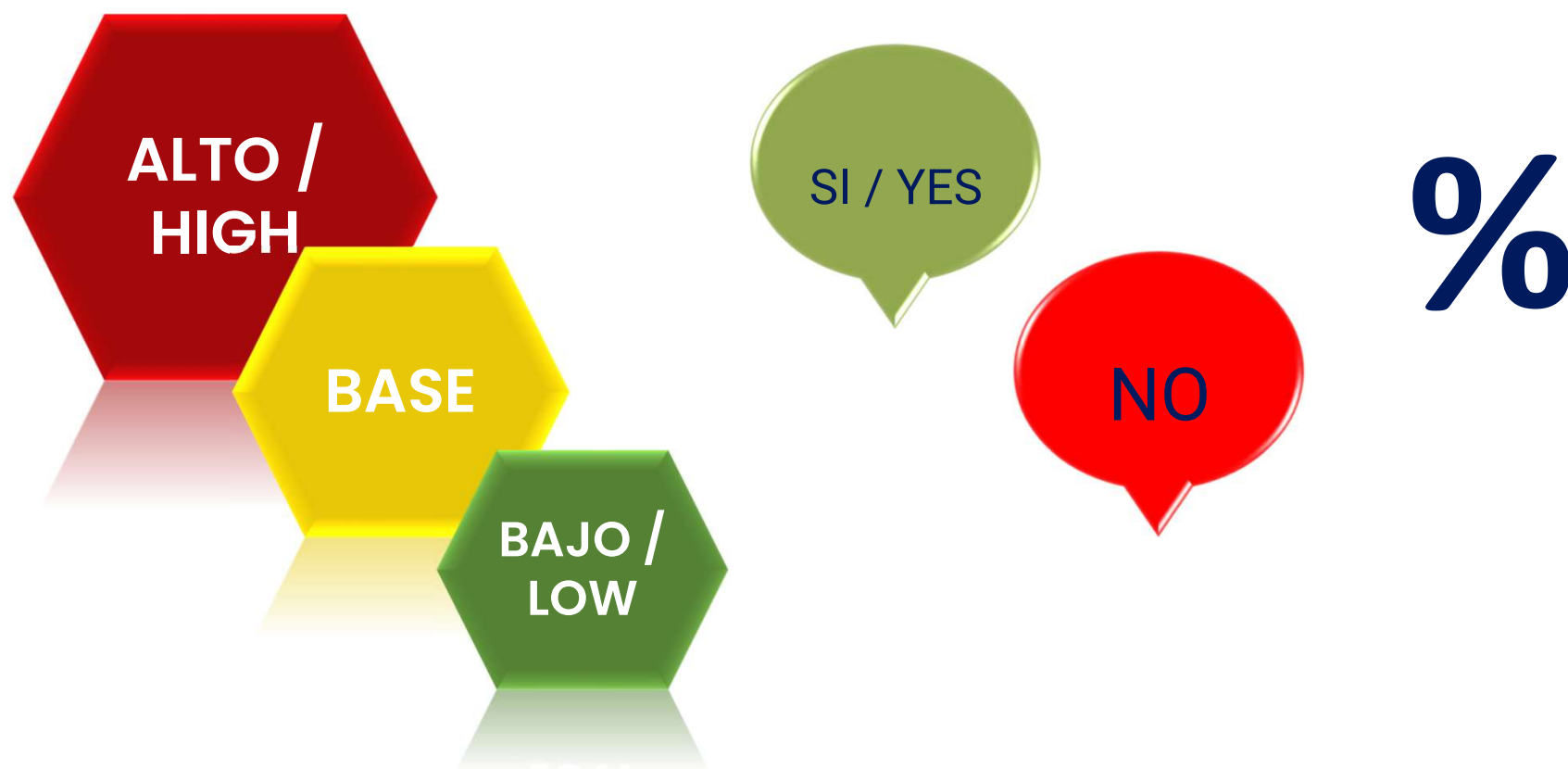
SETPR

-  **Base**
-  **Abundancia de biodiésel a precio de diésel / Plentiful Biodiesel at Cost of Diesel**
-  **Aumento de energía solar y almacenamiento / High Distributed Solar and Storage Growth**
-  **Reducción acelerada de la demanda / Accelerated Load Loss**
-  **Aumento de la demanda y costos optimistas / Optimistic load growth and costs**
-  **Minimizar uso de terrenos agrícolas / Less Ag land use**
-  **Ley 17 Eficiencia Energética / Act 17 EE**
-  **Integración regional con cable marítimo / Marine Cable**

## CARACTERÍSTICAS DE LOS ESCENARIOS



## Variaciones Aplicadas a las Características



# Escenarios del PIR 2024



## Características

#	Escenarios	Crecimiento Demanda	Costo Paneles Solares	Aumento DER	% Control Almacenaje Distribuido	Costo Almacenaje	Nuevas unidades de GN	Costo Combustible Fósil	Costo Biodiesel	Aumento VE	Proyecciones EE	Uso Terrenos Ag.
	Base	Base	Base	Base	0%	Base	SI	Base	Base	Adjusted PR100- Base	PR100- Base	PR100-More Land
	Abundancia de biodiésel a precio del diésel	Base	Base	Base	0%	Base	SI	Base	BAJO	Adjusted PR100- Base	PR100- Base	PR100-More Land
	Aumento de Energía Solar y Almacenamiento	Base	Base	ALTO	20%	BAJO	SI	Base	Base	Original PR100- ALTO	PR100- Base	PR100-More Land
	Reducción acelerada de la demanda	BAJO	Base	Base	0%	Base	No	ALTO	Base	Adjusted PR100- Base	PR100- Base	PR100-More Land
	Aumento de la demanda y costos optimistas	ALTO	BAJO	ALTO	20%	BAJO	SI	BAJO	Base	Original PR100- ALTO	PR100- Base	PR100-More Land
	Minimizar uso de terrenos agrícolas	Base	Base	Base	0%	Base	SI	Base	Base	Adjusted PR100- Base	PR100- Base	PR100-Less Land
	Ley 17 Eficiencia Energética	Base	Base	Base	0%	Base	SI	Base	Base	Adjusted PR100- Base	PR100 ACT 17	PR100-More Land
	Integración regional con cable marítimo	Base	Base	Base	0%	Base	SI	Base	Base	Adjusted PR100- Base	PR100- Base	PR100-More Land

# 2024 IRP Scenarios



#	Scenario Name	Characteristics										
		Load Growth	PV Cost	DER Growth	% Distributed Storage Control	Storage Cost	New Gas Units Allowed	Fossil Fuel Cost	Biodiesel Fuel Cost	EV Growth	EE Forecast	Land Use
	Base Assumptions	Base	Base	Base	0%	Base	Yes	Base	Base	Adjusted PR100- Base	PR100- Base	PR100- More Land
	Plentiful Biodiesel at Cost of Diesel	Base	Base	Base	0%	Base	Yes	Base	Low	Adjusted PR100- Base	PR100- Base	PR100- More Land
	High Distributed Solar and Storage Growth	Base	Base	High	20%	Low	Yes	Base	Base	Original PR100- High	PR100- Base	PR100- More Land
	Accelerated Load Loss	Low	Base	Base	0%	Base	No	High	Base	Adjusted PR100- Base	PR100- Base	PR100- More Land
	Optimistic load growth and costs	High	Low	High	20%	Low	Yes	Low	Base	Original PR100- High	PR100- Base	PR100- More Land
	Less Ag land use	Base	Base	Base	0%	Base	Yes	Base	Base	Adjusted PR100- Base	PR100- Base	PR100- Less Land
	Act 17 EE	Base	Base	Base	0%	Base	Yes	Base	Base	Adjusted PR100- Base	PR100 Act 17	PR100- More Land
	Marine Cable	Base	Base	Base	0%	Base	Yes	Base	Base	Adjusted PR100- Base	PR100- Base	PR100- More Land



## Introducción del enfoque de modelaje en PLEXOS / Introduction to PLEXOS Modeling

\* PLEXOS es un programa (software) utilizado para crear pronósticos de precios de energía, considerando aumentos de energía renovable y rentabilidad del almacenamiento de baterías con una precisión sin precedentes

\* PLEXOS is a program (software) used to create energy price forecasts, considering increases in renewable energy and profitability of battery storage with unprecedented accuracy

\* Se utiliza para realizar simulaciones de mercado en las industrias de electricidad, gas y agua

\* It is used to perform market simulations in the electricity, gas and water industries

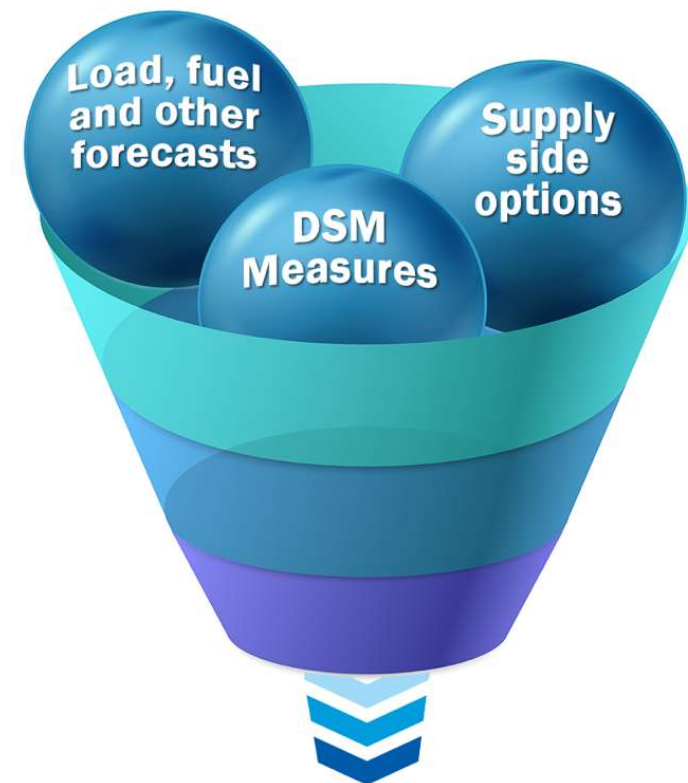
## Optimización mediante modelado PLEXOS

El sistema eléctrico de Puerto Rico se replica dentro de una base de datos PLEXOS (un “Gemelo Digital”)

- Las propiedades y comportamientos del sistema físico actual y futuro se convierten en un sistema matemático.
- Luego se realiza una optimización en el sistema para identificar qué opciones de recursos deben implementarse, en qué años y en qué números para satisfacer la demanda al menor costo total de capital y operativo.

La optimización es tanto para recursos (expansión de capacidad) como para operación (simulación operativa)

La optimización de un escenario puede tardar varias horas o días en ejecutarse



**Operación y expansión de capacidad óptimas**

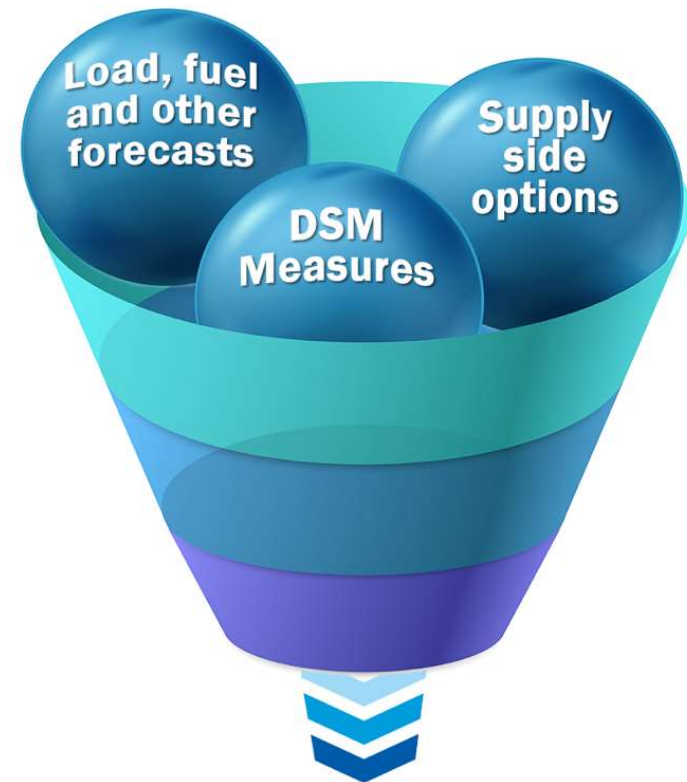
## Optimization through PLEXOS Modeling

The Puerto Rico electrical system is replicated within a PLEXOS database (a “Digital Twin”)

- Properties and behaviors of the current and future physical system are converted into a mathematical system
- An optimization is then performed on the system to identify which resource options should be implemented in which years and in which numbers to satisfy the demand at the lowest total overall capital and operating cost

Optimization is for both resources (capacity expansion) and operation (operating simulation)

Optimization of a scenario can take several hours or days to run

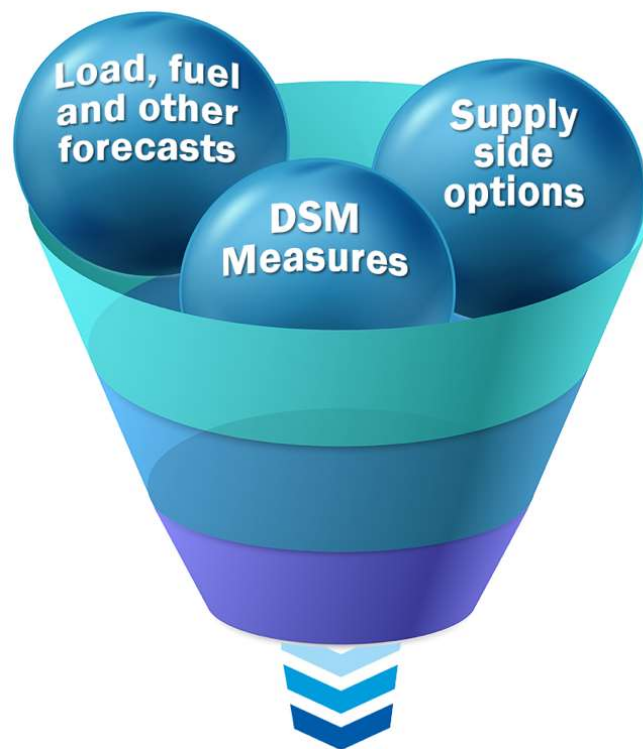


**Optimal Capacity Expansion and Operation**

## Alcanzar múltiples objetivos con PLEXOS

PLEXOS puede identificar la combinación de recursos futuros para lograr o medir el progreso hacia múltiples objetivos que incluyen:

- Minimización de costos (el valor presente de los requisitos de ingresos (PVRR))
- Agregar nueva generación para cumplir los objetivos de energías renovables (60 % para 2040, 100 % para 2050)
- Medir las emisiones y reducciones de carbono.
- Planificación de suministros de energía locales/distribuidos para facilitar la resiliencia y confiabilidad del sistema.

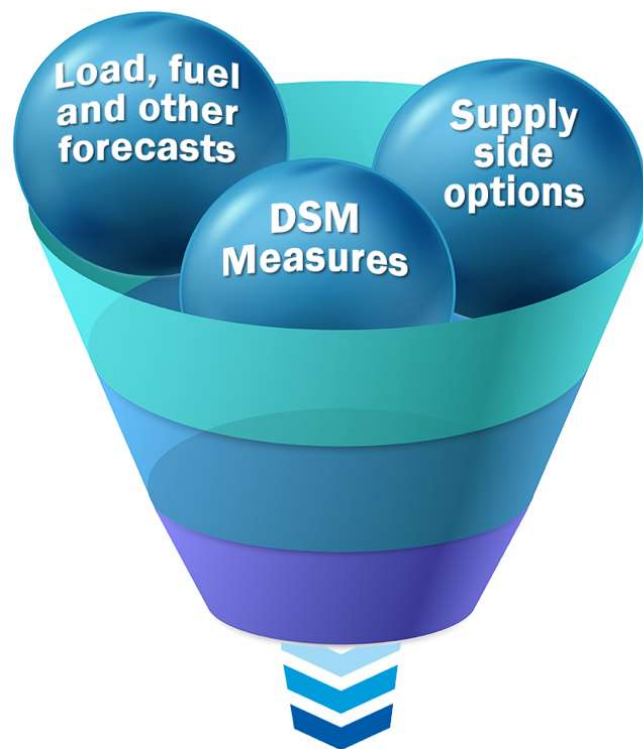


Operación y expansión de capacidad óptimas

## Achieving Multiple Objectives with PLEXOS

PLEXOS can identify the mix of future resources to achieve or measure progress toward multiple objectives including:

- Cost minimization (the present value of revenue requirements (PVRR))
- Adding new generation to meet RE targets (60% by 2040, 100% by 2050)
- Measure carbon emissions and reductions
- Planning for local/distributed power supplies to facilitate system resiliency & reliability



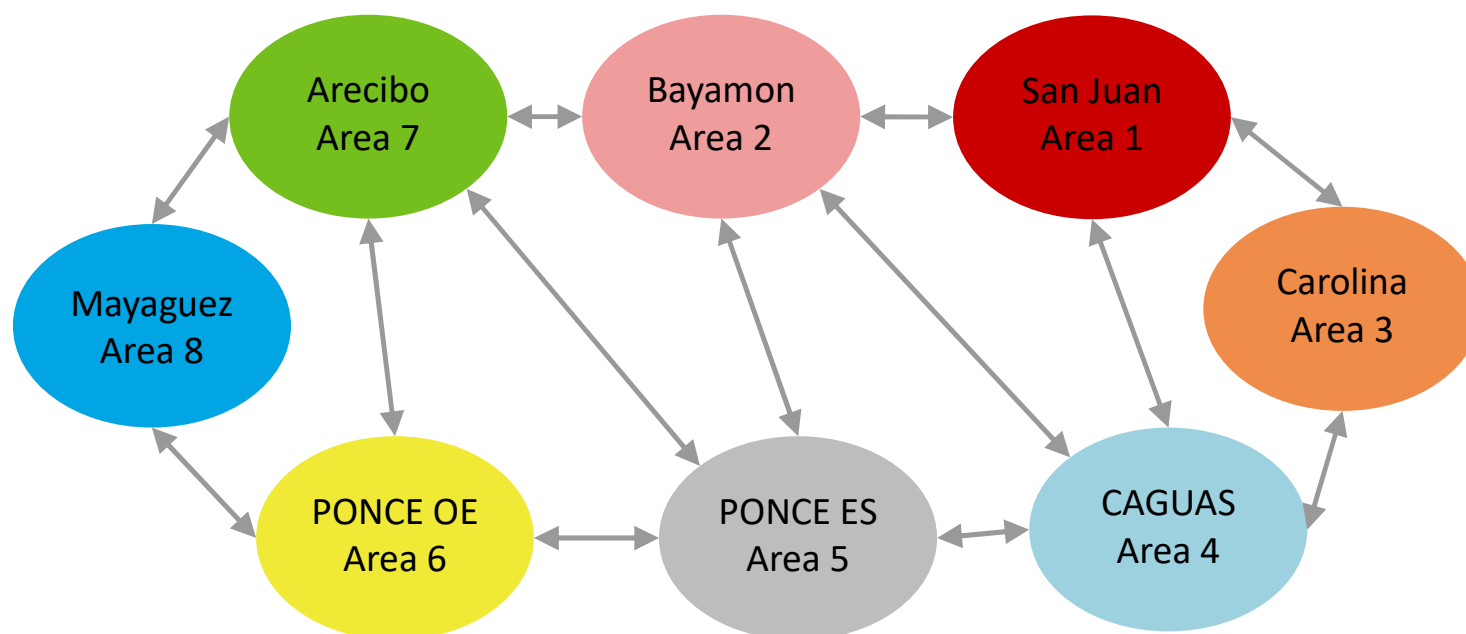
**Optimal Capacity Expansion and Operation**

## Modelaje PLEXOS: 8 Áreas de Planificación de Transmisión\*



\*Modelaje de las 8 áreas de planificación de transmisión. Límites territoriales no se alinean ni con el alojamiento de energía solar fotovoltaica distribuida ni con los mapas de Fiona.

## PR Transmission Planning: Observing Regional Transfer Capacity





## Calculating the Present Value of Revenue Requirements

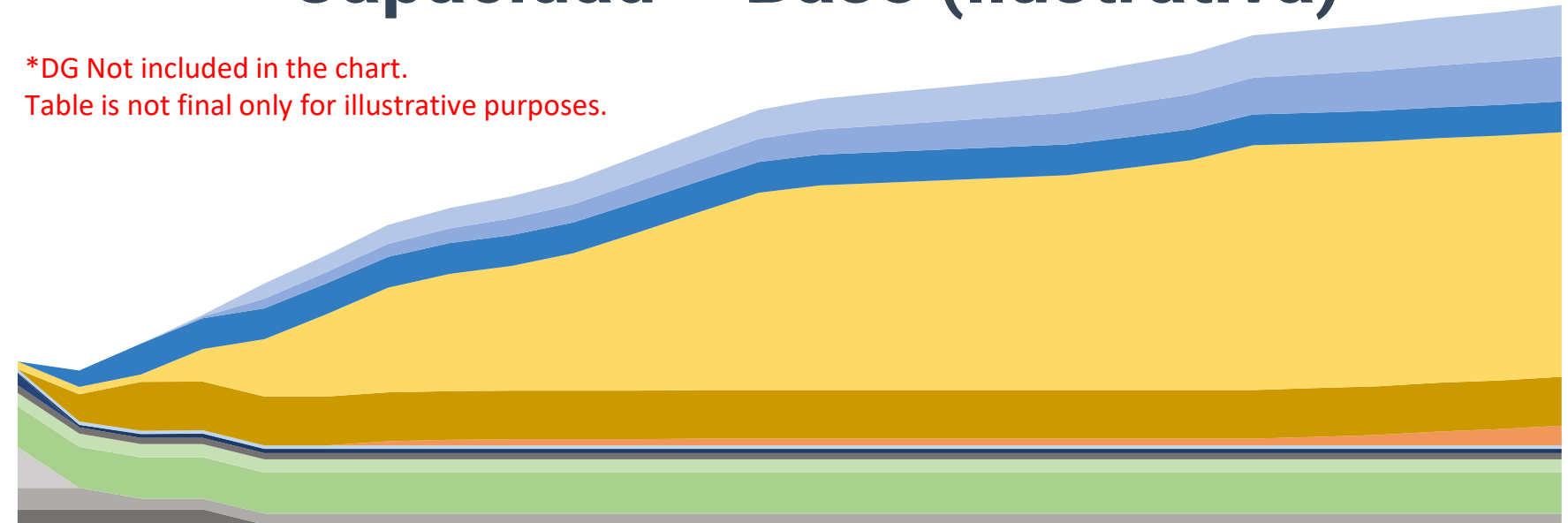
System PVRR over the Study Period (2024-2050)

	2024	2025	2026	2027	2028	... 2050
<b>Energy Costs</b>	\$	\$	\$	\$	\$	\$
System fuel Costs	\$	\$	\$	\$	\$	\$
System Variable O&M	\$	\$	\$	\$	\$	\$
<b>Fixed Costs</b>	\$	\$	\$	\$	\$	\$
Fixed O&M	\$	\$	\$	\$	\$	\$
Capital Cost, New Generation	\$	\$	\$	\$	\$	\$
<b>Total Incremental Annual Cost</b>	\$	\$	\$	\$	\$	\$
	↓	↓	↓	↓	↓	↓
	PVRR \$ ←					

## Capacidad – Base (Ilustrativa)

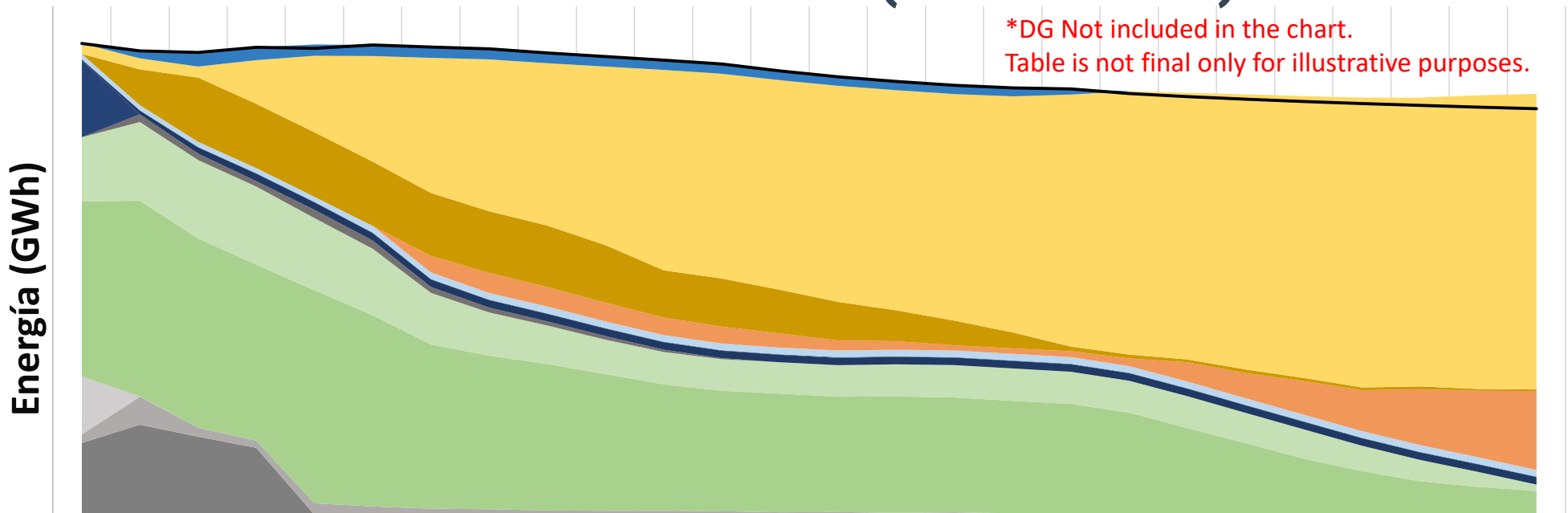
\*DG Not included in the chart.  
Table is not final only for illustrative purposes.

Capacidad (MW)



- |                         |                              |                         |                               |                         |
|-------------------------|------------------------------|-------------------------|-------------------------------|-------------------------|
| ■ Coal                  | ■ Diesel                     | ■ Fuel Oil              | ■ LNG - EcoElec               | ■ LNG - SanJuan         |
| ■ Diesel/Biodiesel      | ■ FEMA Fuel                  | ■ Hydro                 | ■ Landfill                    | ■ LNG                   |
| ■ LBW                   | ■ Biodiesel                  | ■ OSW                   | ■ Solar - Tranche Procurement | ■ UPV                   |
| ■ Solar-Distributed*    | ■ BESS - Tranche Procurement | ■ Battery Storage - 4hr | ■ Battery Storage - 8hr       | ■ Battery Storage - 2hr |
| ■ Battery Storage - 6hr | ■ Battery Storage - 10hr     | ■ Distributed BESS      |                               |                         |

## Generación – Base (Ilustrativa)

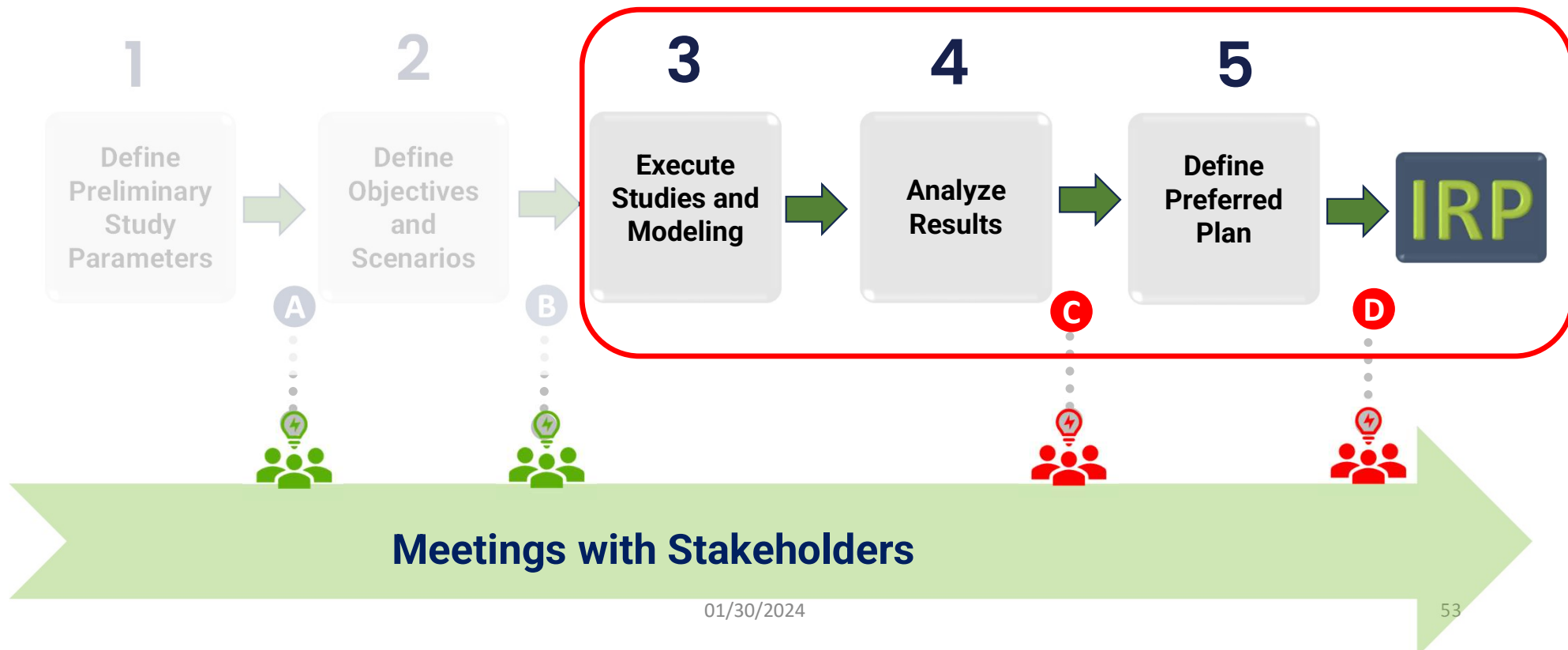


- |                    |             |                     |                     |                               |
|--------------------|-------------|---------------------|---------------------|-------------------------------|
| ■ Coal             | ■ Diesel    | ■ Fuel Oil          | ■ LNG - EcoElec     | ■ LNG - SanJuan               |
| ■ Diesel/Biodiesel | ■ FEMA Fuel | ■ Hydro             | ■ Landfill          | ■ LNG                         |
| ■ LBW              | ■ Biodiesel | ■ OSW               | ■ Solar-Distributed | ■ Solar - Tranche Procurement |
| ■ UPV              | ■ Storage   | — System Load (GWh) |                     |                               |

# Próximos Pasos



# Next Steps



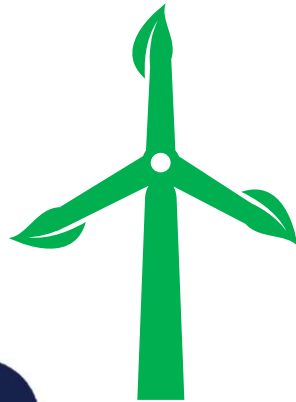
# Participa con SETPR

SETPR

*Soluciones Energéticas para la Transformación de Puerto Rico (SETPR)*

[www.setpr.com](http://www.setpr.com)

[info@setpr.com](mailto:info@setpr.com)



Hoja de Evaluación Presentación  
Objetivos y Escenarios



SETPR

# Soluciones Energéticas para Transformar a Puerto Rico



**¡Gracias!**  
**Thank you!**

Thursday, February 8, 2024

