Long-Term Power Sector Development Plan to Achieve 100% Renewable Energy Island:

The Study Case of Sumbawa and Timor Island

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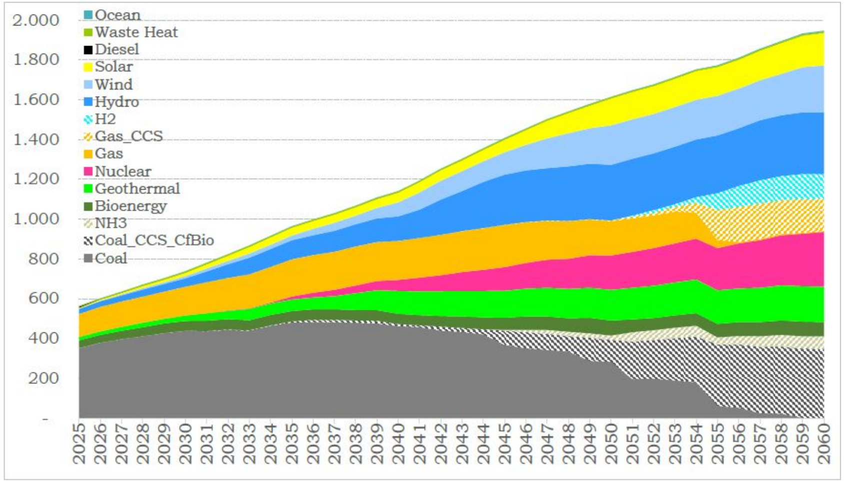
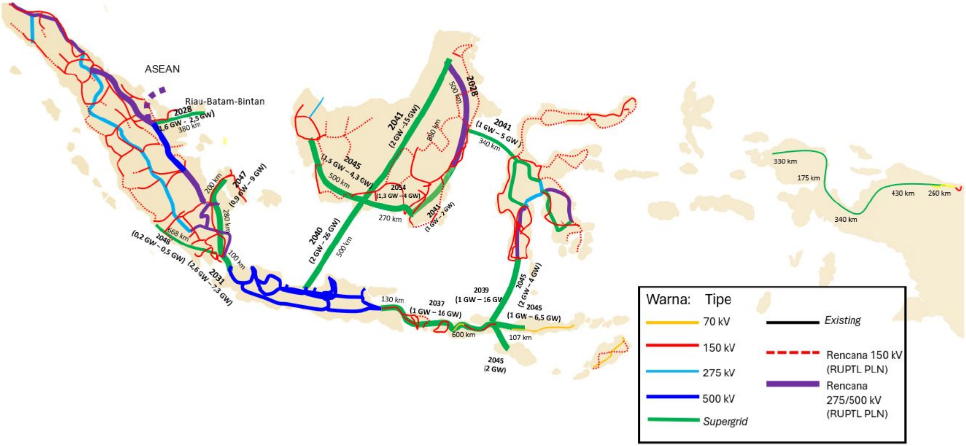
Indonesia’s Vast Archipelago Presents an Opportunity for an Island-based Decarbonization

National Electricity Generation from RUKN 2025-2060



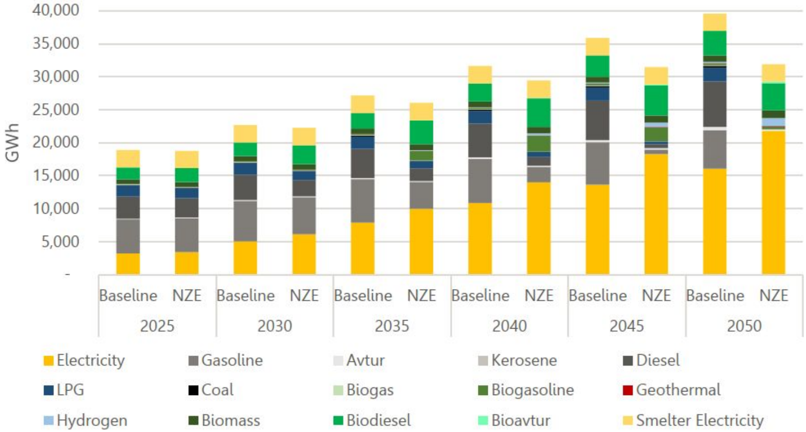
Inter-island transmission plan (‘*supergrid*’) from RUKN 2025-2060



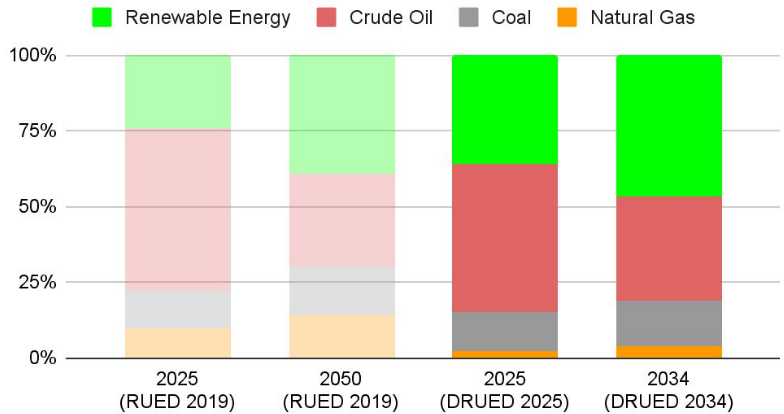
- The National General Electricity Plan (RUKN) 2025-2060 envisioned a **carbon-free electricity system** by 2060 in Indonesia
- New system planning paradigm: a **resilient** power system supplied by **local renewable resources** to complement the ‘supergrid.’

Strong Political Will from the Provincial Government Serves as a Platform to Achieve a 100% Renewable Energy Island

West Nusa Tenggara



East Nusa Tenggara



- NTB Governor Regulation No. 43/2024: Clean Energy Roadmap towards **energy sector net-zero emission in 2050.** Electricity makes up to 68% of final energy consumption in 2050.

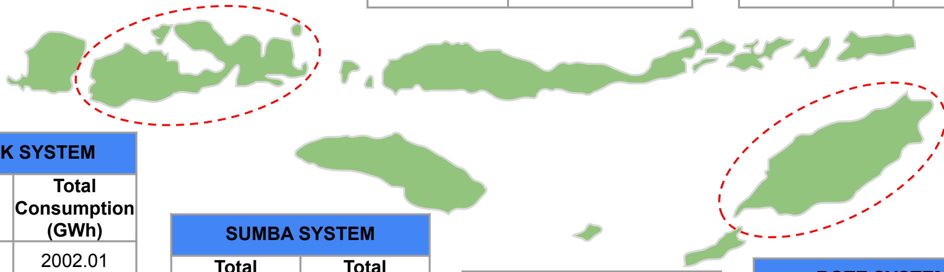
- Renewal of Regional General Energy Plan (RUED) NTT 2025-2034: **47% renewable energy in primary energy mix by 2034,** currently in finalization.

West and East Nusa Tenggara Boast Significant Renewable Energy Potential

TAMBORA (SUMBAWA-BIMA SYSTEM)	
Total Capacity (MW)	Total Consumption (GWh)
179.88	851.12

FLORES SYSTEM	
Total Capacity (MW)	Total Consumption (GWh)
151.23	498.16

ALOR SYSTEM	
Total Capacity (MW)	Total Consumption (GWh)
19.74	39.73



TIMOR SYSTEM	
Total Capacity (MW)	Total Consumption (GWh)
181.75	626.77

LOMBOK SYSTEM	
Total Capacity (MW)	Total Consumption (GWh)
410.83	2002.01

SUMBA SYSTEM	
Total Capacity (MW)	Total Consumption (GWh)
14.56	120.42

SABU SYSTEM	
Total Capacity (MW)	Total Consumption (GWh)
6.37	15.56

ROTE SYSTEM	
Total Capacity (MW)	Total Consumption (GWh)
8.06	32.63

38 GW

NTB Renewable Energy Potential

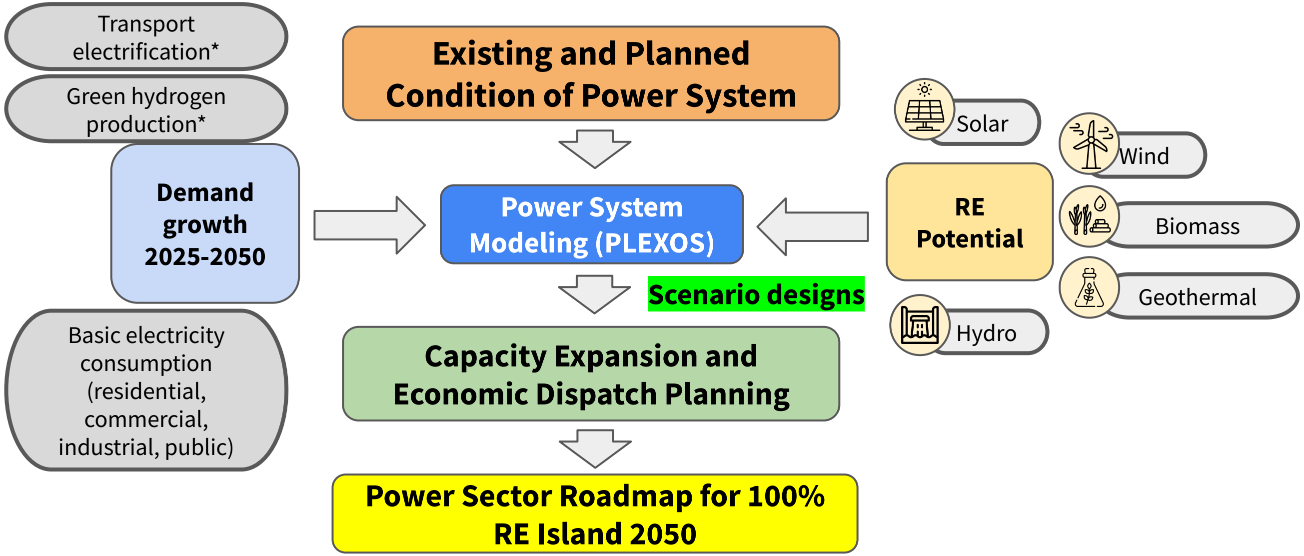
388 GW

NTT Renewable Energy Potential

Using **Sumbawa Island (NTB)** and **Timor Island (NTT)** as study cases, this study aims to

- Asses the **optimal pathway** to achieve 100% renewable energy island by 2050
- Asses the **enabling environment** required to implement the optimal pathway
- Provide appropriate **policy recommendations** for national and subnational stakeholders

General Approach for Power System Modeling

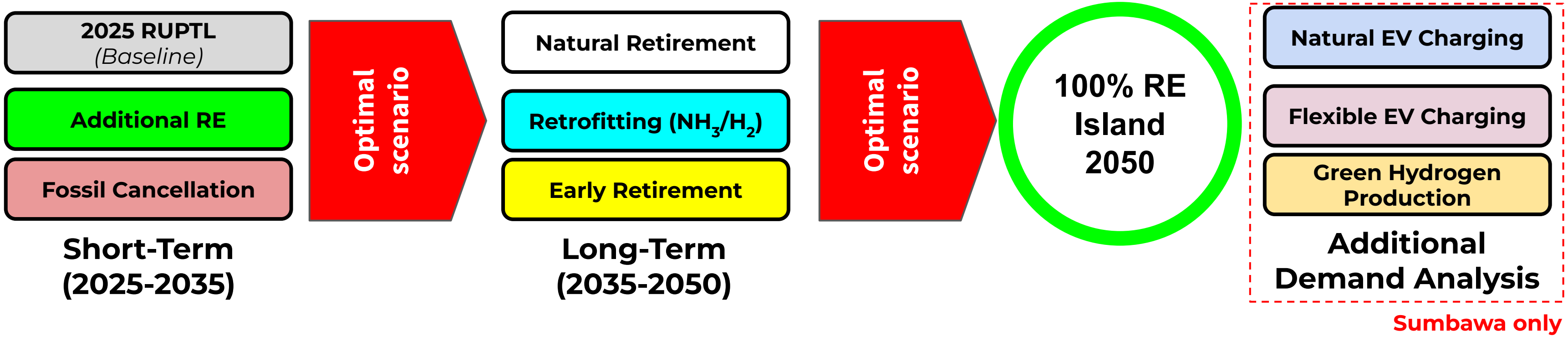


PLEXOS Simulation parameter	Value
Horizon	2025 - 2050
Expansion optimization step	6 years per step with 1 year overlap
Load details	Hourly
Sampled days for expansion	14 days per year
VRE profile details	Hourly
Minimum capacity margin	35%

Limitation of this study:

- Only considers **on-grid systems**; does not include off-grid isolated system or captive sites
- Limited to only **capacity expansion** and **economic dispatch** study; further power system studies need to be conducted to evaluate the technical details

Optimal Pathway Development for 100% Renewable Energy Island



Multi-Criteria Analysis for Optimal Scenario Selection

Criteria	Lowest System & Generation Cost	Lowest Emission Level	Highest Renewable Energy Mix	Lowest Total Investment Needs
Points for 1st-ranked scenario	3	3	3	3
Points for 2nd-ranked scenario	2	2	2	2
Points for 3rd-ranked scenario	1	1	1	1
Criteria weightings	40%	15%	15%	30%

Scenario Design for Short-Term and Long-Term Analysis

Short-Term (2025-2035) Scenario	RUPTL 2025 (baseline)	Additional RE	Fossil Cancellation
Planned coal and gas plants based on 2025-2034 RUPTL PLN	Build according to 2025-2034 RUPTL	Build according to 2025-2034 RUPTL	Optional, allowed to be built based on optimization
Planned renewable energy plants based on 2025-2034 RUPTL PLN	Build according to 2025-2034 RUPTL	Build according to 2025-2034 RUPTL	Build according to 2025-2034 RUPTL
Additional renewable energy plant (outside 2025-2034 RUPTL PLN)	No additional RE power plant	New RE power plant candidates are allowed	New RE power plant candidates are allowed

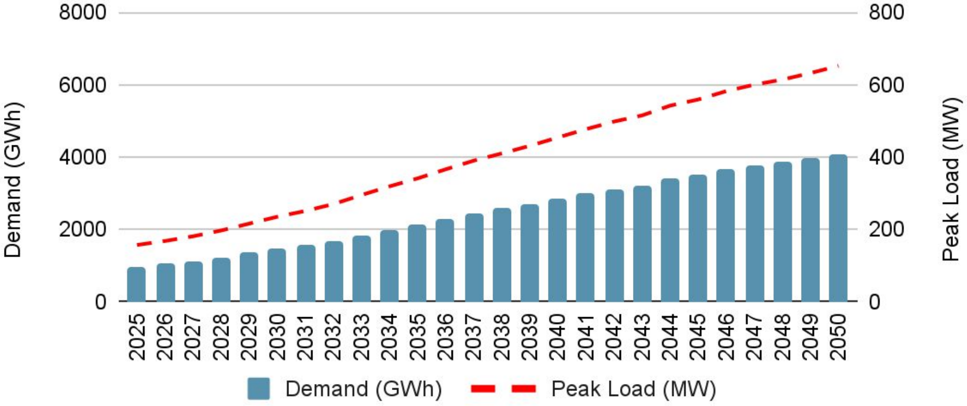
Long-Term (2036-2050) Scenario	Natural Retirement	Retrofitting	Early Retirement
Existing/ planned coal and fossil power plant	Retired at the end of the operational lifetime	Retrofitted into ammonia and hydrogen plant for coal and gas power plants, respectively, at the end of operational lifetime or at 2050	Allowed to retire early after 20 years of operation


Study Case #1: Sumbawa Island

Tambora (Sumbawa-Bima) Current & Planned Power System

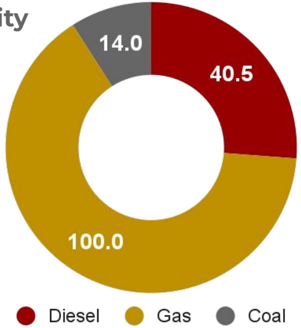
Sumbawa Power System

Electricity Demand & Peak Load Projection



Installed Power Plant Capacity

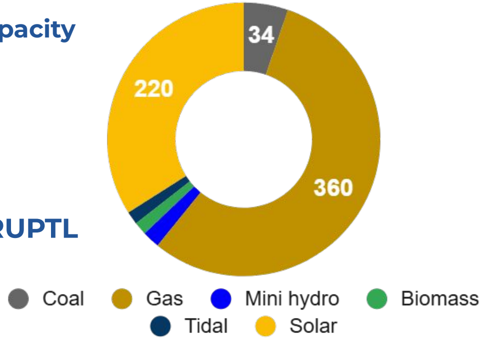
154.5 MW (2025)



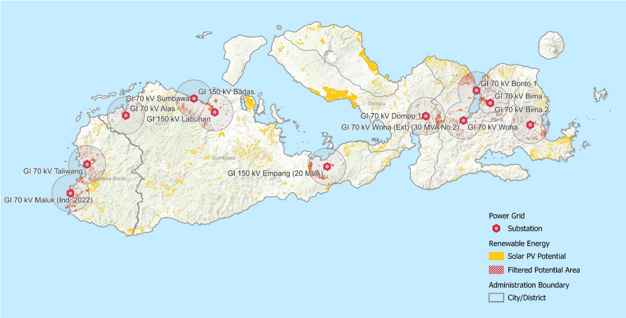
Installed Power Plant Capacity

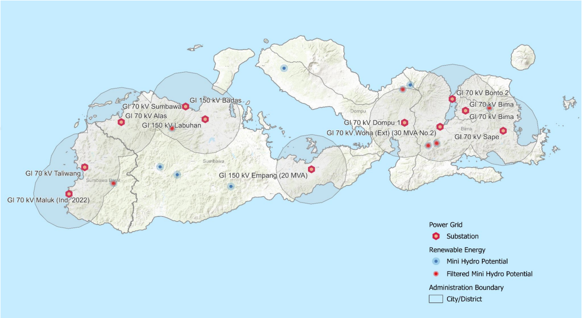
647.3 MW (2034)

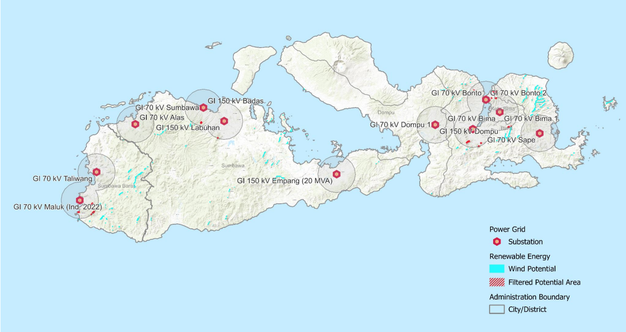
From 2025-2034 PLN RUPTL

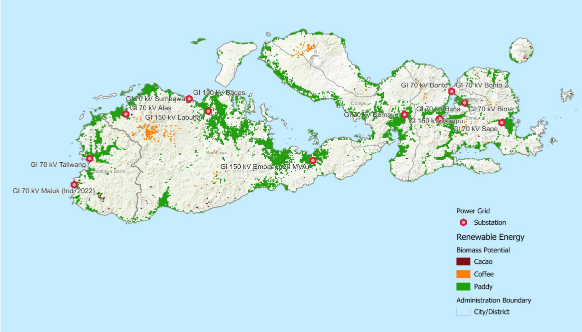


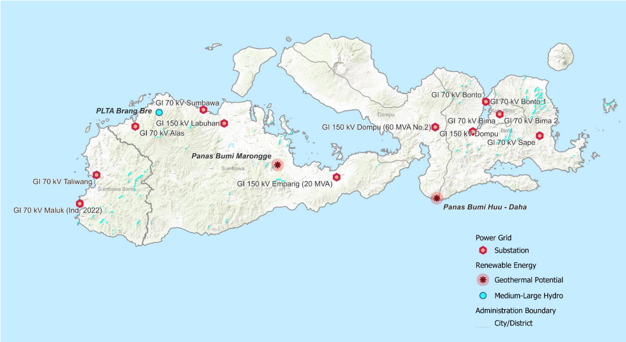
Sumbawa Island Renewable Energy Potential Mapping











8.64 GW Solar

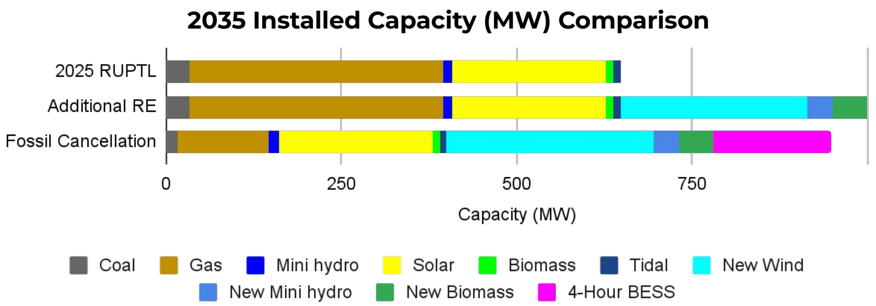
1.45 GW Wind

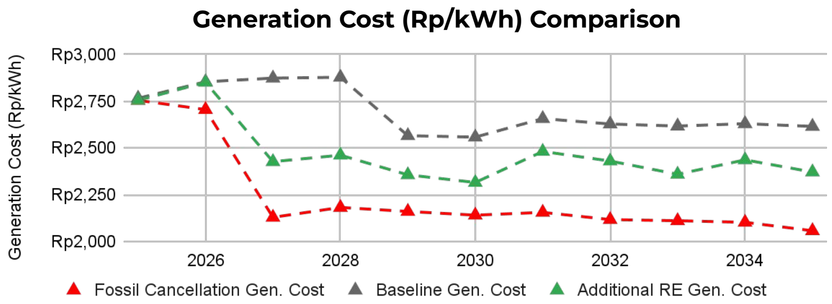
30 MW Geothermal

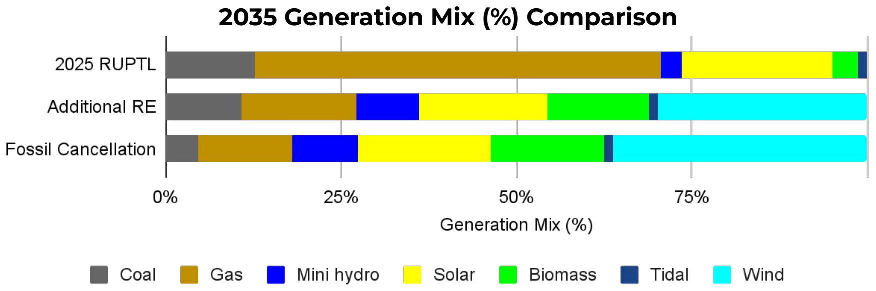
36 MW Hydro

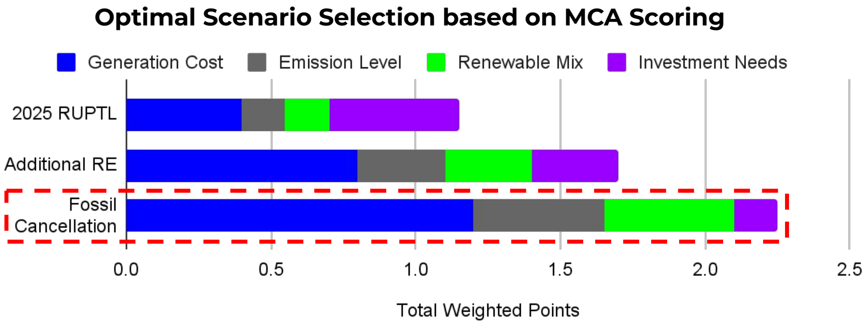
56.5 MW Biomass

Short-Term (2025-2035) Analysis Results







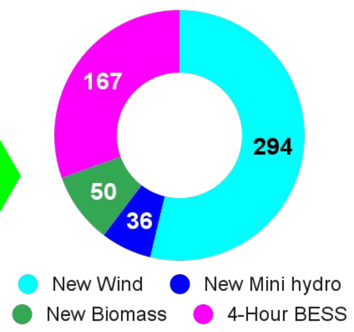


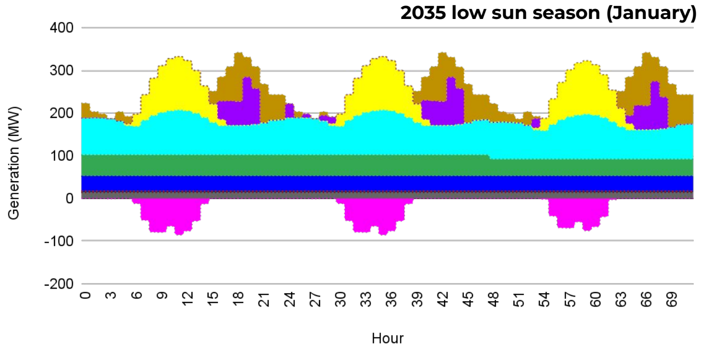
Fossil Cancellation Scenario Snapshots

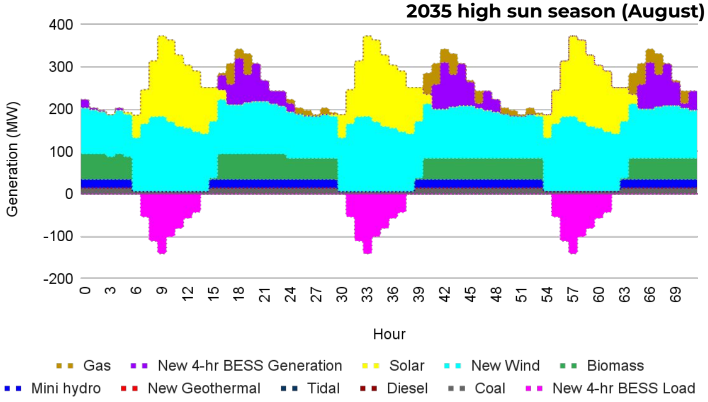
Replaced Fossil Power Plants in the Pipeline

Name	Technology	Capacity (MW)	COD Year	End Year
Sumbawa 3	Gas Engine	50	2026	2051
Sumbawa 4	Gas Engine	50	2027	2052
Bima (FTP 1) - 1	Coal Subcritical	10	2029	2059
Bima (FTP 1) - 2	Coal Subcritical	10	2029	2059
Sumbawa 5	Gas Engine	50	2031	2056
Bima 2 - 1	Gas Engine	15	2031	2056
Bima 2 - 2	Gas Engine	15	2031	2056
Sumbawa 6	Gas Engine	50	2034	2059

RE + BESS Replacement (MW)

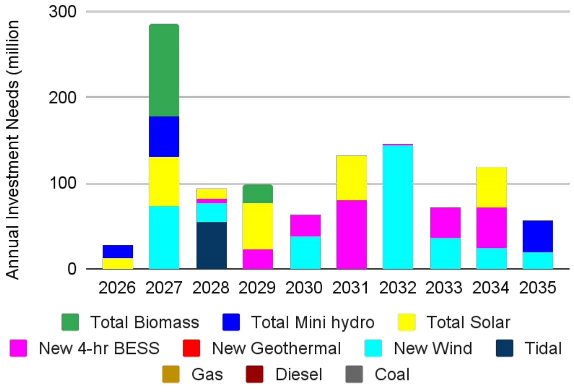




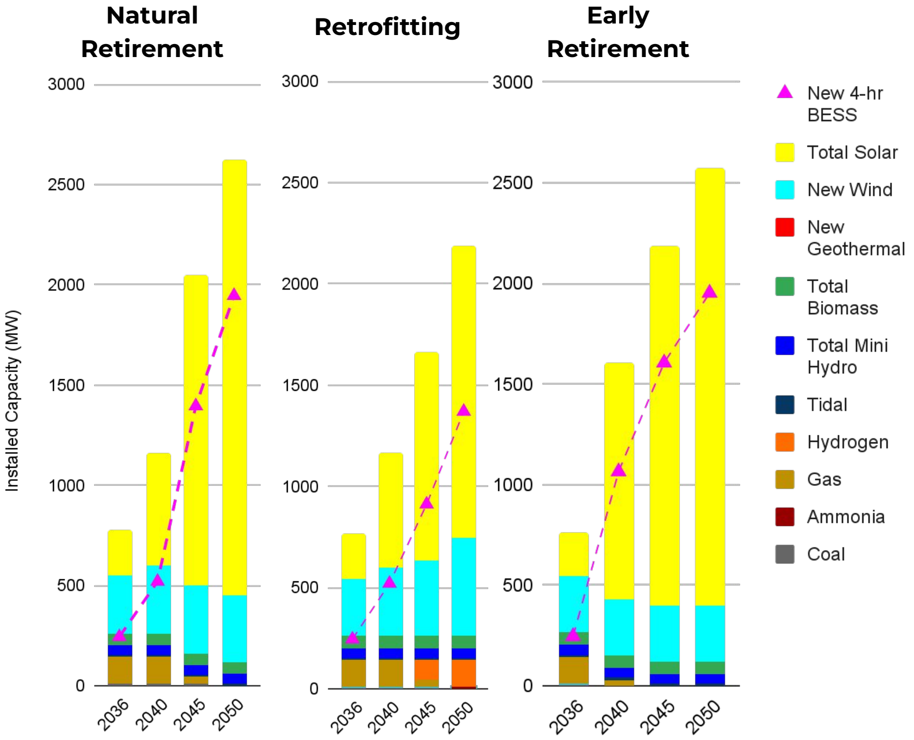


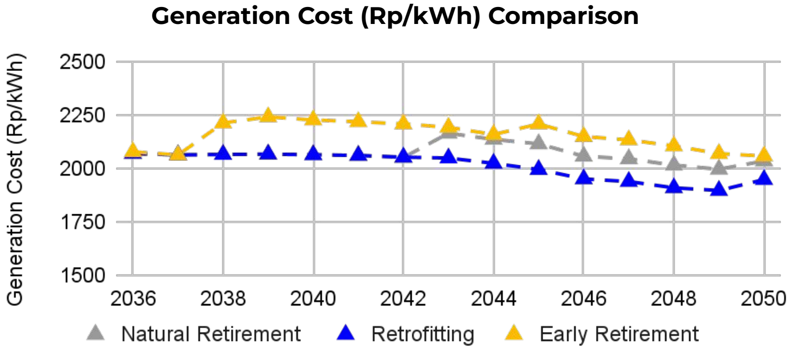
295 million USD
Avoided fossil power plant investment

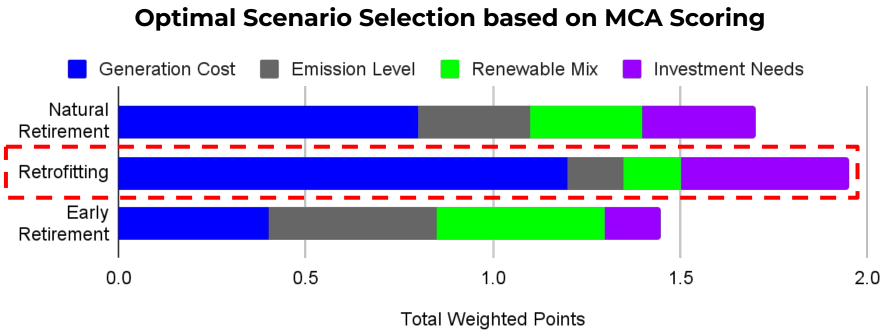
768 million USD
Investment requirement for renewable replacements



Long-Term (2036-2050) Analysis Results





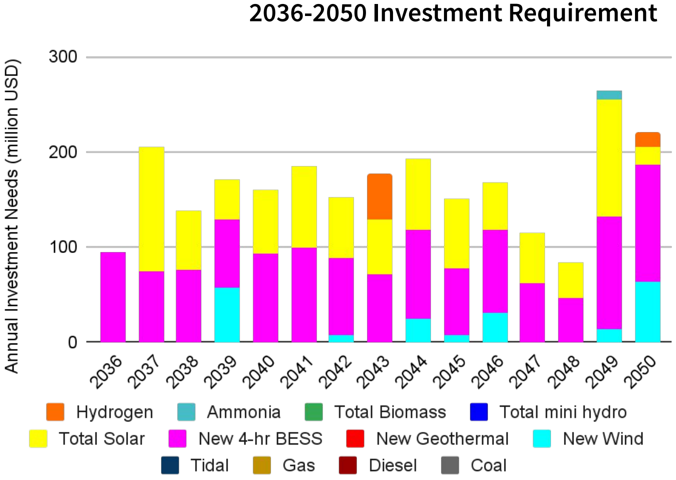


Retrofitting Scenario Snapshots

Retrofit Year and Cost for Coal and Gas Power Plant

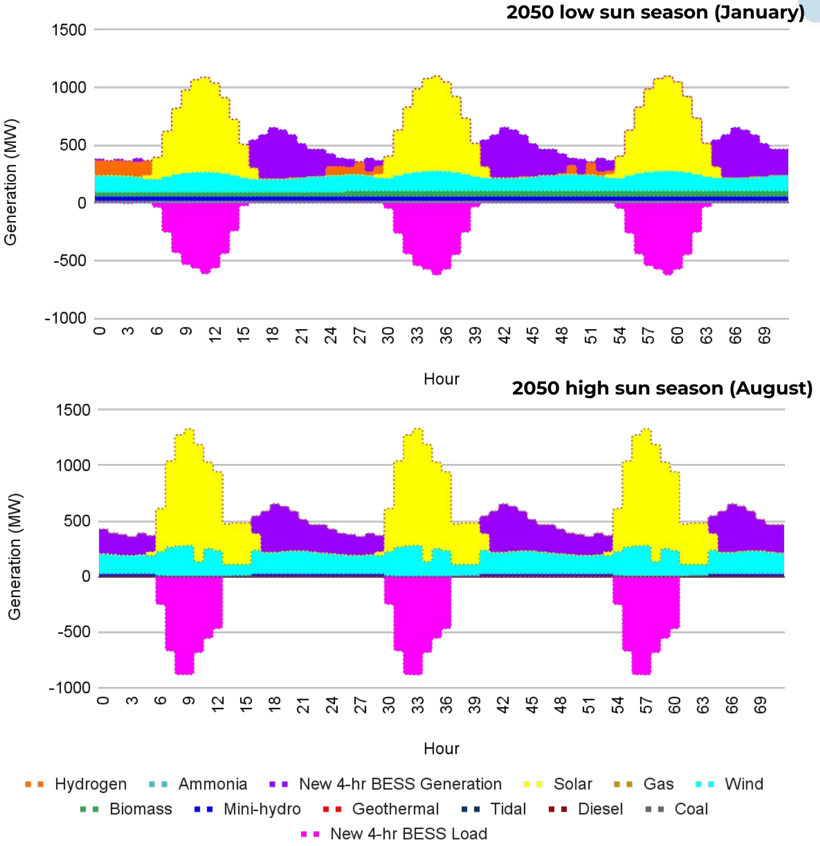
Name	Capacity (MW)	Natural End Year	Retrofit Year	Retrofit Cost (million USD)	Technology
Sumbawa	50	2043	2043	23.9	Hydrogen
Bima	50	2043	2043	23.9	Hydrogen
Sumbawa 2	30	2050	2050	14.4	Hydrogen
West Sumbawa	14	2049	2049	8.7	Ammonia

70.82 million USD
Estimated investment for hydrogen/ammonia retrofitting



2.2 billion USD

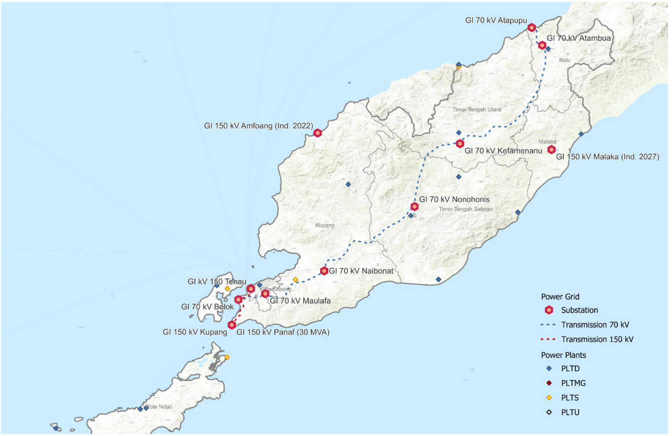
Estimated renewable + energy storage investment requirement (2036-2050)



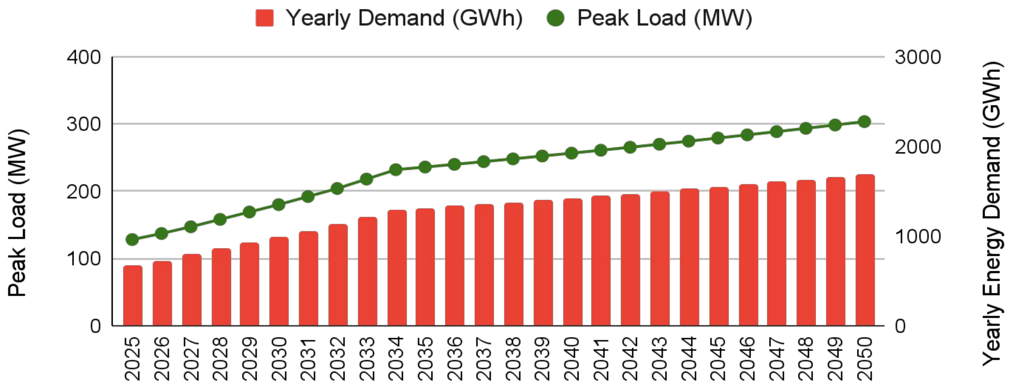
Study Case #2: Timor Island

Timor Current & Planned Power System

Timor Power System

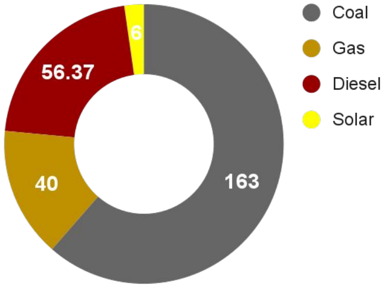


Electricity Demand & Peak Load Projection



Installed Power Plant Capacity

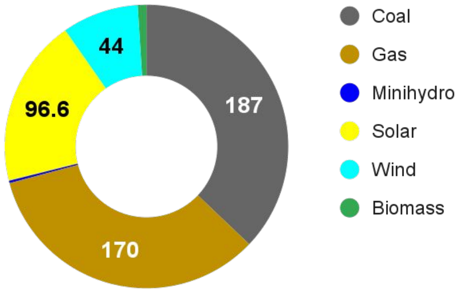
265 MW (2025)



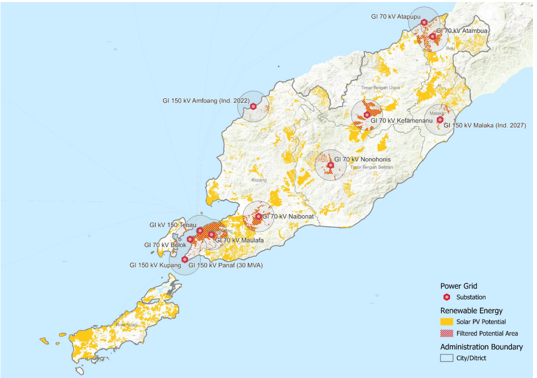
Installed Power Plant Capacity

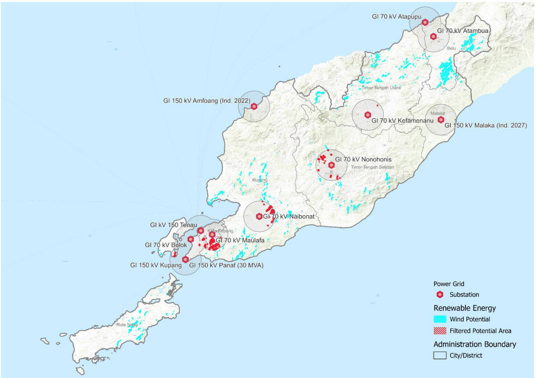
504 MW (2034)

From 2025-2034 PLN RUPTL



Timor Island Renewable Energy Potential Mapping





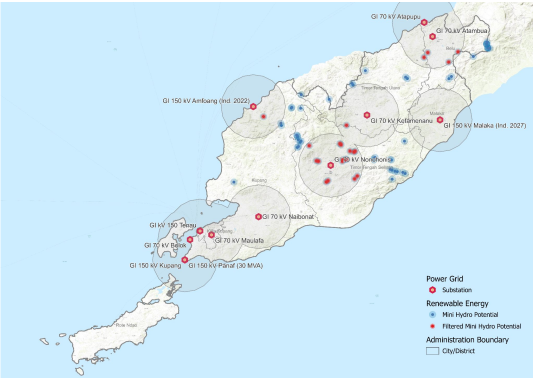
20.7 GW
Solar

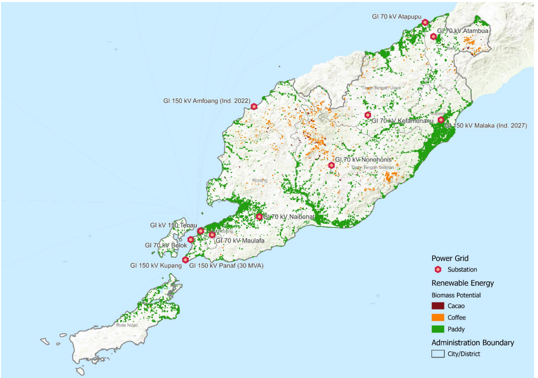
10 GW
Wind

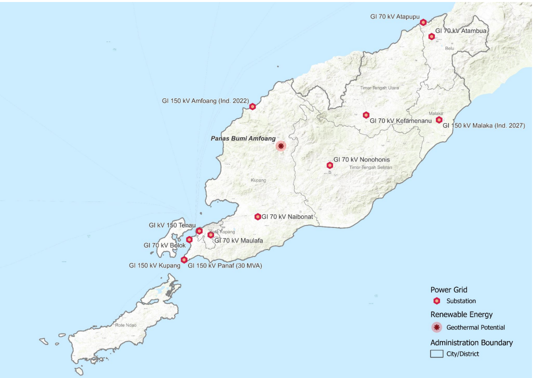
10 MW
Geothermal

44 MW
Hydro

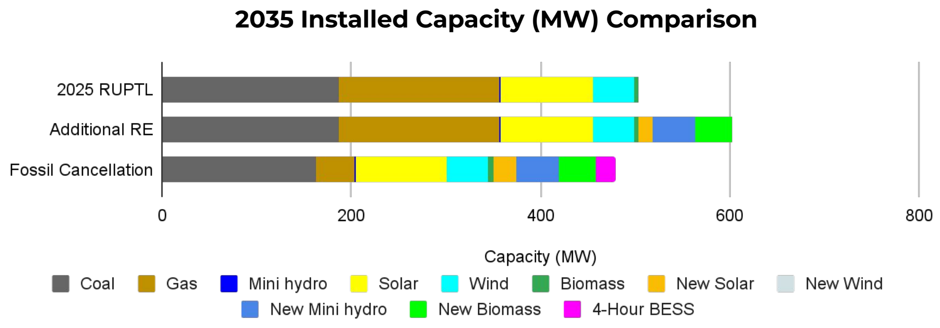
42 MW
Biomass

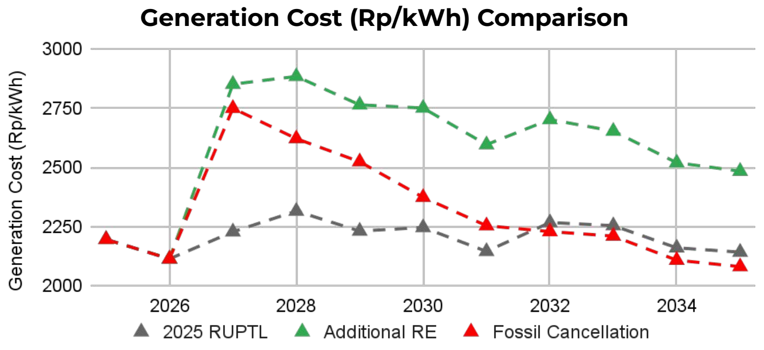


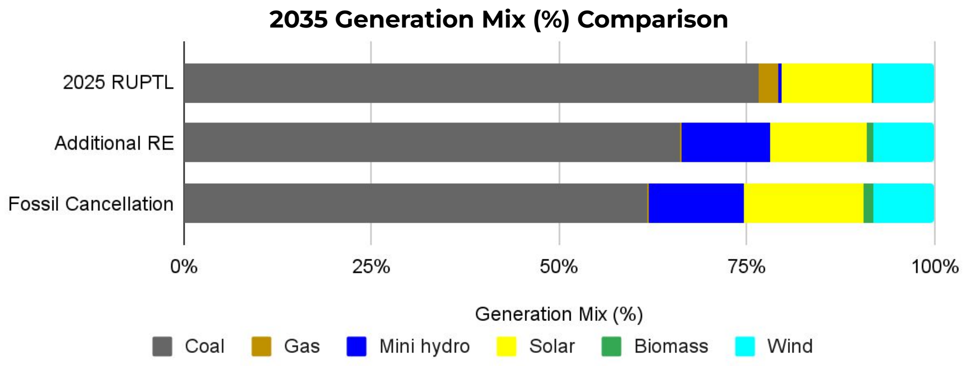


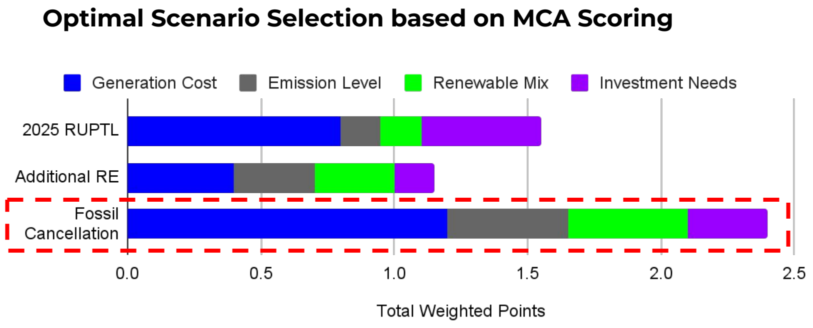


Short-Term (2025-2035) Analysis Results







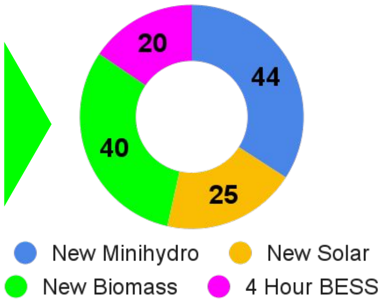


Fossil Cancellation Scenario Snapshots

Replaced Fossil Power Plants in the Pipeline

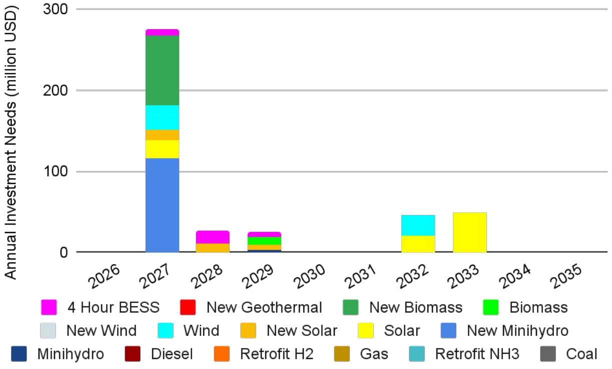
Name	Technology	Capacity (MW)	COD year	Natural End year
Kupang 2	Gas Machine	30	2027	2052
Timor 2	Gas Machine	50	2028	2053
Atambua	Coal Subcritical	24	2030	2059
Timor	Gas Machine	50	2032	2057

RE + BESS Replacements (MW)

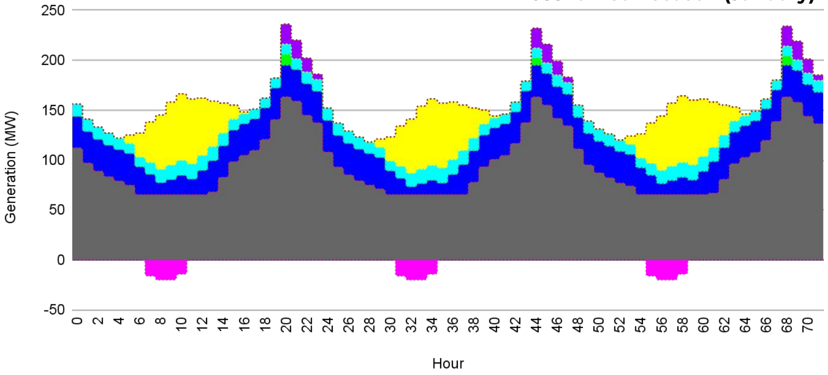


191 million USD
Avoided fossil power plant investment

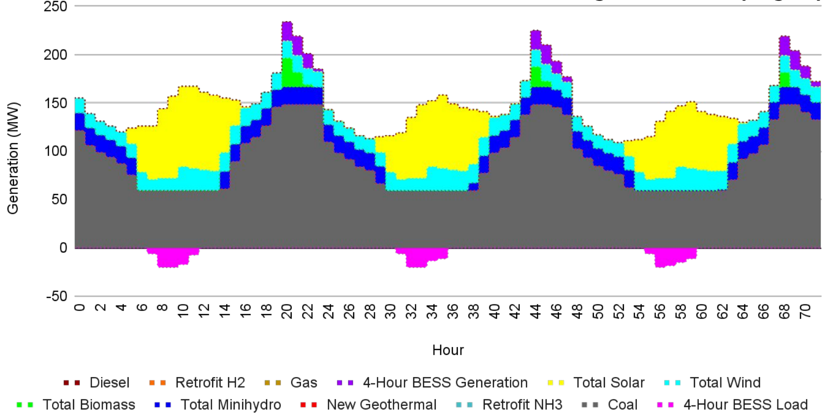
260 million USD
Investment requirement for renewable replacements



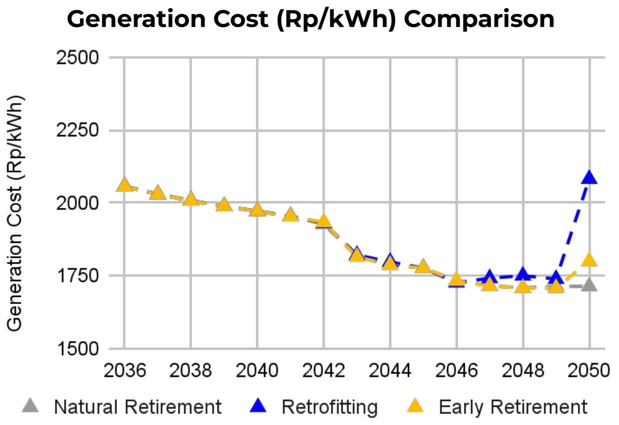
2035 low sun season (January)

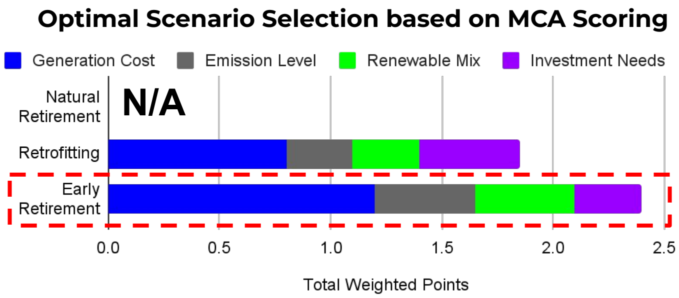


2035 high sun season (August)



Long-Term (2036-2050) Analysis Results



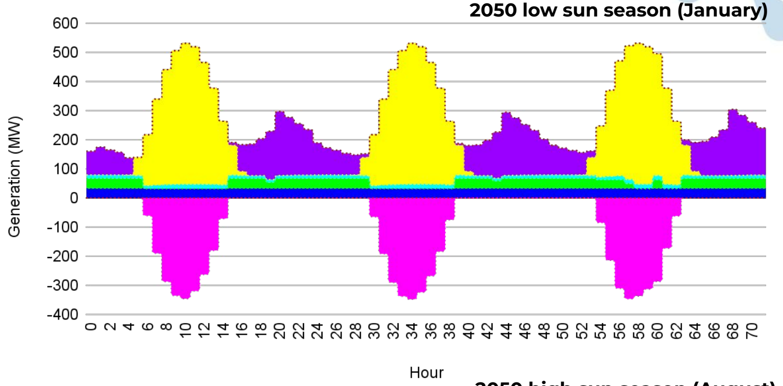


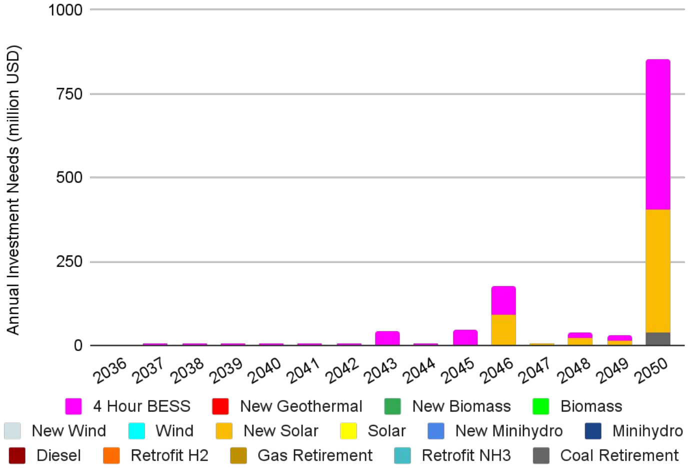
Early Retirement Scenario Snapshots

Name	Capacity (MW)	Natural end year	Early retirement year
Bolok CFPP	2 x 16.5	2043	-
Bolok IPP CFPP	2 x 15	2046	-
Kupang Peaker GEPP	40	2045	-
Timor CFPP	2 x 50	2053	2050

36.5 million USD

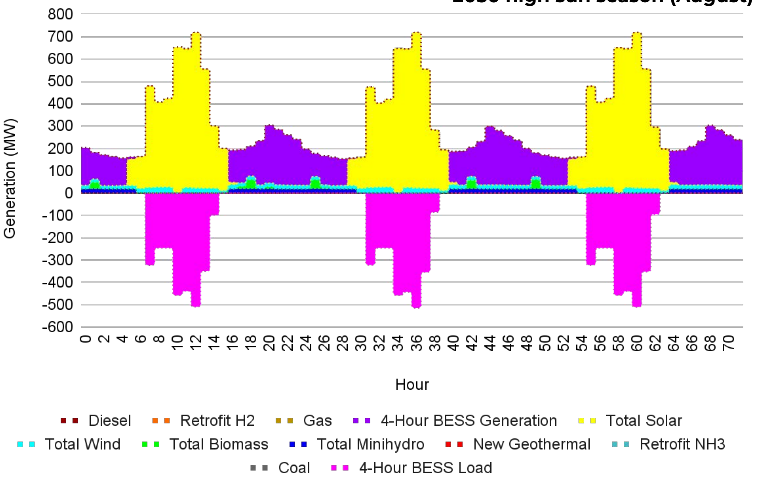
Estimated early retirement cost for Timor CFPP





815.5 million USD

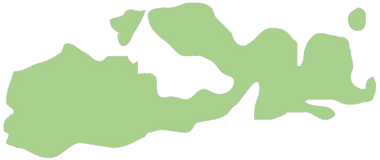
Estimated investment requirement for Timor CFPP's renewable replacements in 2050

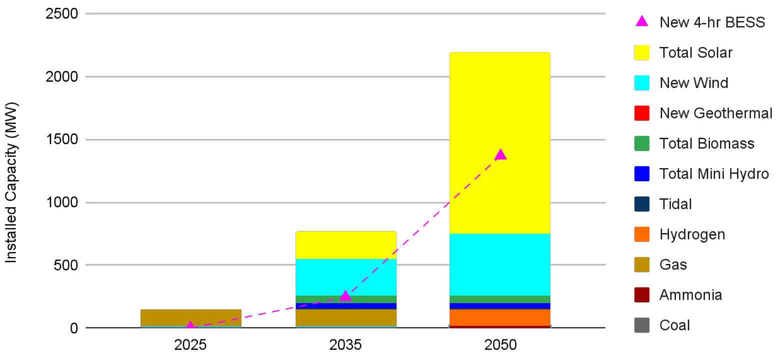


Summary and Key Takeaways

Summary of Optimal Pathway towards 100% RE Island

Sumbawa Island





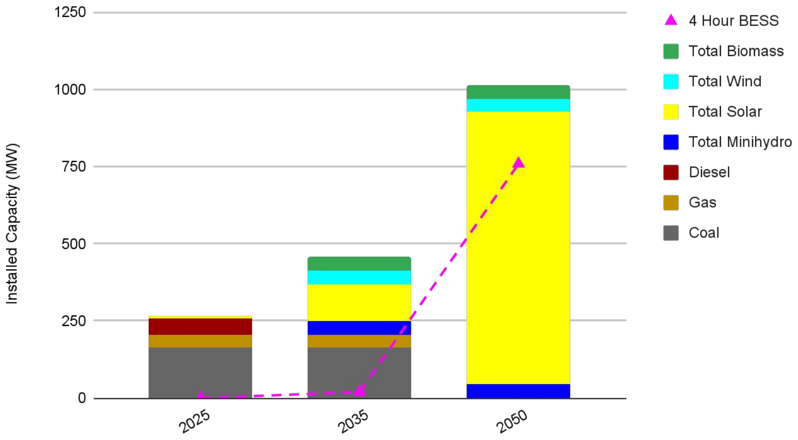
3.58 billion USD

2026-2050 Investment Requirement

1.43 TWh/year

2050 Daily Flexibility Requirement

Timor Island



1.63 billion USD

2026-2050 Investment Requirement

0.9 TWh/year

2050 Daily Flexibility Requirement

Short-term Enabling Conditions

- Prepare a mechanism to replace planned fossil power plants with new renewable energy projects beyond the current RUPTL.
- Enable flexible operation of coal power plants by reassessing PPA clauses and introducing new incentives, such as capacity reserve payments.
- Incentivize private sector participation in BESS development by creating viable business models for load-following and peak-shaving applications.
- Improve and streamline the renewable energy procurement process, including project bundling to enhance economies of scale.

Long-term Enabling Conditions

- Integrate the green hydrogen development roadmap into regional energy development planning and encouraging pilot implementation
- Prepare financing and legal mechanisms for early coal retirement
- Prepare a regulation or business scheme to enable demand-side management
- Invest in long-duration storage technology development
- Improve grid infrastructure to accommodate higher VRE penetration in the future

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