KNS Conference

Structuring First Indonesia Nuclear Power Plant Projects as Emerging Nuclear Nations: A Four-Dimensional AHP Decision Model

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Based on the First Author's Master's Thesis at KINGS

WHY THIS MATTERS NOW

Indonesia's 2032 target meets a framework gap

2032

Target year for Indonesia's first-of-a-kind nuclear power plant (RUKN and RUPTL)

35 GW

Cumulative nuclear capacity targeted by 2060

>60%

Share of national electricity still generated by coal

BBB

Investment-grade sovereign rating; Fitch and Moody's outlooks are negative

THE GAP

Indonesia has no established framework to choose the ownership model and contractual structure for this megaproject.

WITHOUT THE RIGHT STRUCTURE, EXPECT

- **A failed financial close**
- **Cost overrun**
- **Unsustainable sovereign debt**

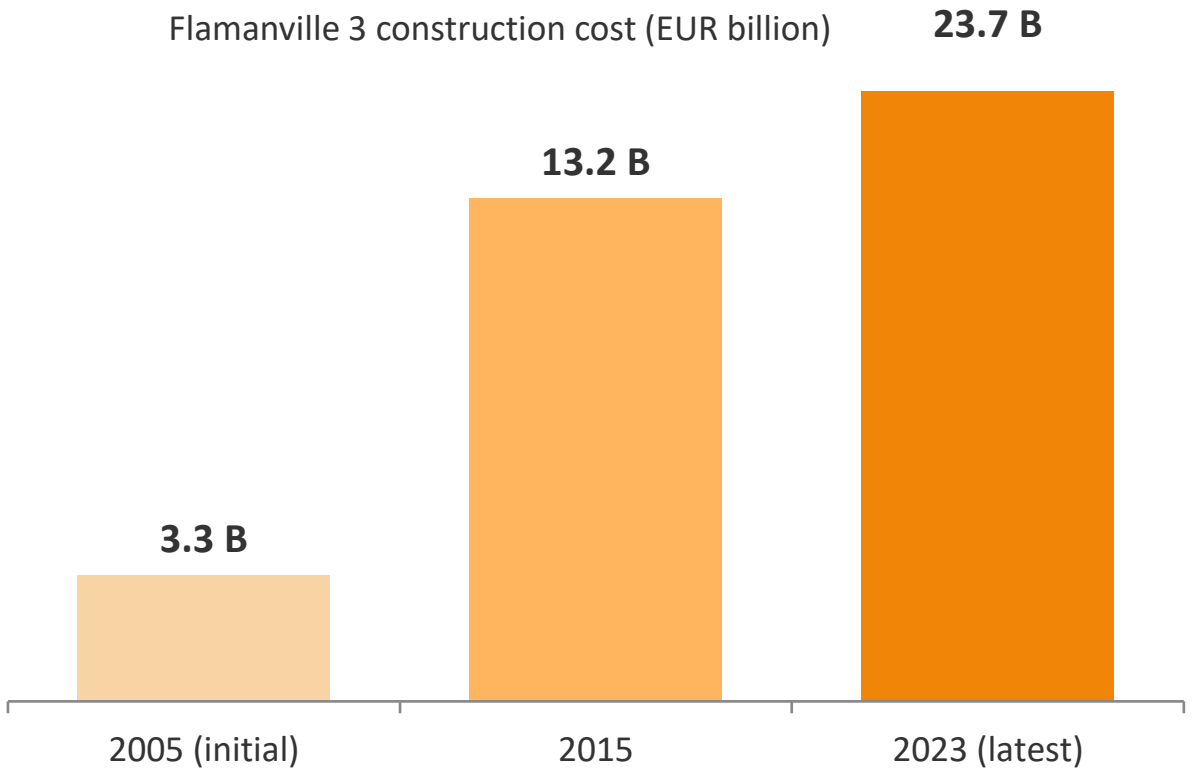
THE COST OF GETTING IT WRONG

The cost of getting the structure wrong

7×

Flamanville 3 (France) grew from EUR 3.3 B in 2005 to EUR 13.2 B in 2015 and Final Actual Cost to EUR 23.7 B in 2023 (*Cour de Comptes*). A First-of-a-Kind unit financed on EDF's own balance sheet, with no EPC risk transfer.

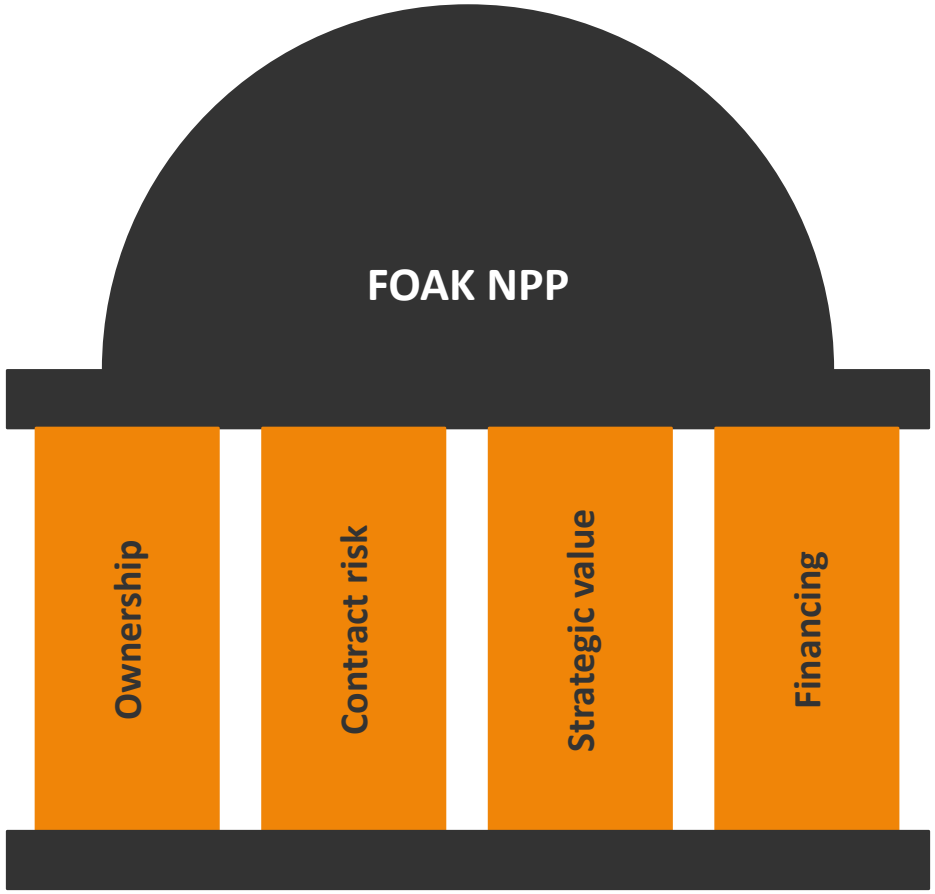
Structure decides who absorbs the overrun.



Structure first, reactor second.

CORE IDEA

Our idea: four pillars under one reactor



WHAT YOU WILL TAKE AWAY

1

A lens

A four-dimensional model to compare any NPP project structure.

2

Evidence

Five global megaprojects, rated by 19 Indonesian experts.

3

An answer

A ranked structure for Indonesia, and how robust it is.

"Structure first, reactor second."

FRAMEWORK

Four dimensions, fourteen criteria

GOAL The most suitable project structure for Indonesia's first NPP

1 Project Entity Ownership

- Domestic Company Capacity
- Degree of Vendor Dependence
- Project Regulatory Compliance
- Government Regulatory Oversight (BAPETEN)

2 Contractual Risk Allocation

- Revenue Guarantee
- Construction Risk Allocation
- Government Guarantee

3 Strategic National Value

- Alignment with National Energy Security
- Transfer of Technology
- Domestic Industrial Development (TKDN)

4 Financing Feasibility & Capital Cost

- Project Bankability
- Sovereign Risk Sensitivity
- Accessibility of Funding Sources
- Debt-Equity Structure Feasibility

ALTERNATIVES RATED Barakah · Hinkley Point C · Akkuyu · Vogtle 3&4 · Flamanville 3

Research design at a glance

1 — Select cases

Five recent megaprojects with five ownership structures.

2 — Build hierarchy

4 dimensions and 14 sub-criteria.

3 — Survey experts

19 experts, 15 institutions; Google Form and AHP-OS; 26 Jun – 13 Jul 2026.

4 — Derive weights

Pairwise comparison, Saaty 1–9; CR ≤ 0.10.

5 — Rate cases

Anchored 1–9 scale; 14 sub-criteria × 5 cases.

6 — Synthesize

Geometric mean, share of five, × global weight.

7 — Stress-test

Weight scenarios, breakeven, leave-one-out.

Output: dimension weights, sub-criteria weights, and a priority score for each of the five alternatives.

METHOD

How we elicited Indonesia's priorities

19 experts on the panel

15 domestic nuclear-sector institutions

95 comparison matrices, all CR ≤ 0.10 (max 0.0999)

5 global NPP megaprojects as alternatives

1

Pairwise comparison

Saaty's 1–9 scale; 24 judgments per expert across five nodes, run in AHP-OS.

2

Consistency check

CR ≤ 0.10 enforced at every node. No respondent was excluded.

3

Direct rating of cases

Anchored 1–9 scale; the 19 ratings are pooled with a geometric mean.

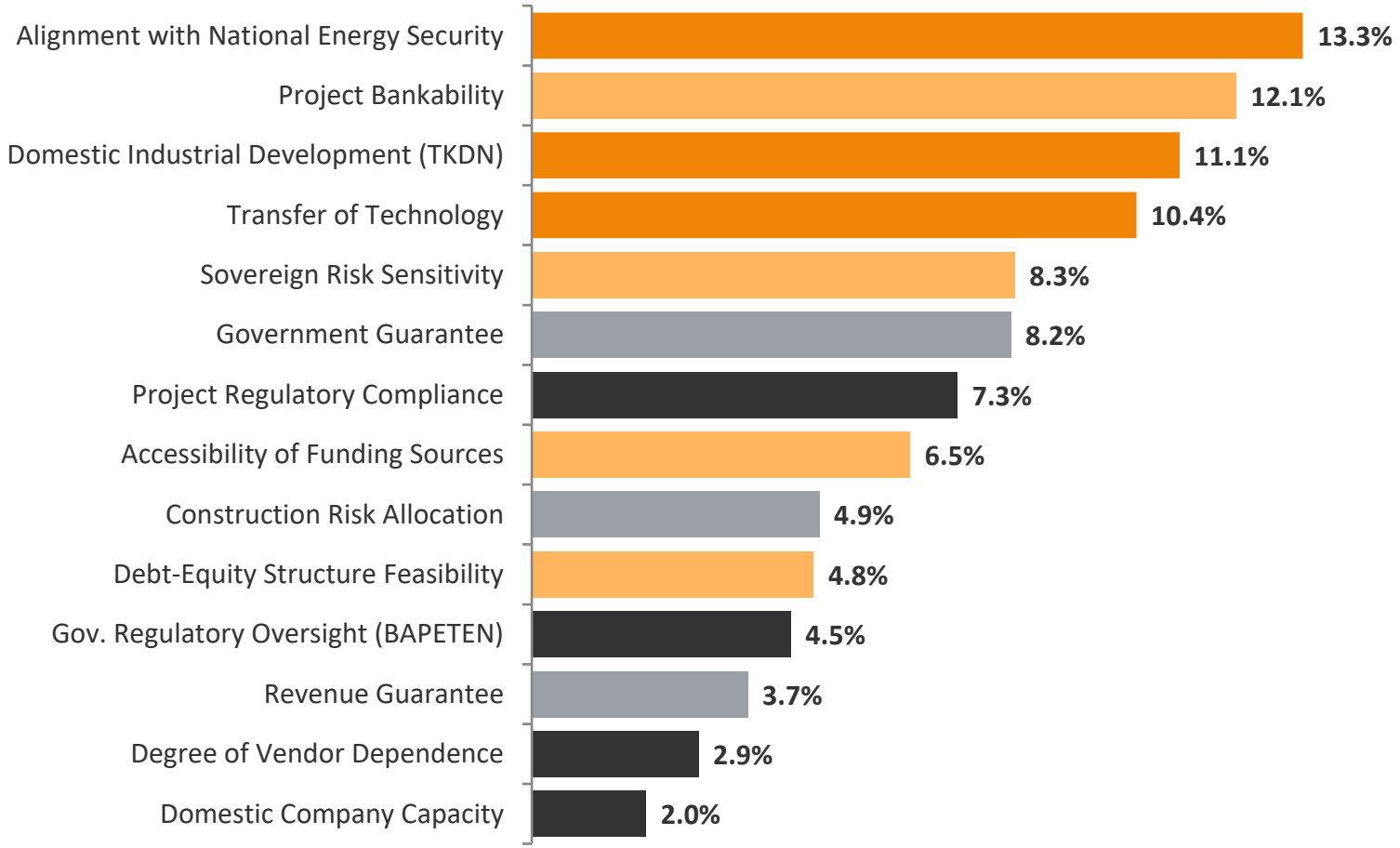
4

Synthesis

Each case's share of ratings × global sub-criteria weight, summed, gives its priority score.

BACKUP · SUB-CRITERIA

Which criteria drive the result



- Project Entity Ownership
- Contractual Risk Allocation
- Strategic National Value
- Financing Feasibility & Capital Cost

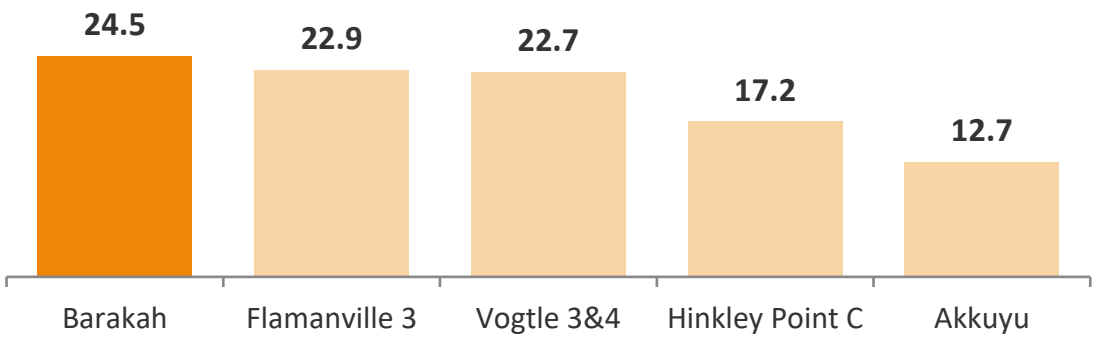
46.9%

of the weight sits in four sub-criteria: energy-security alignment, bankability, domestic industry, and technology transfer.

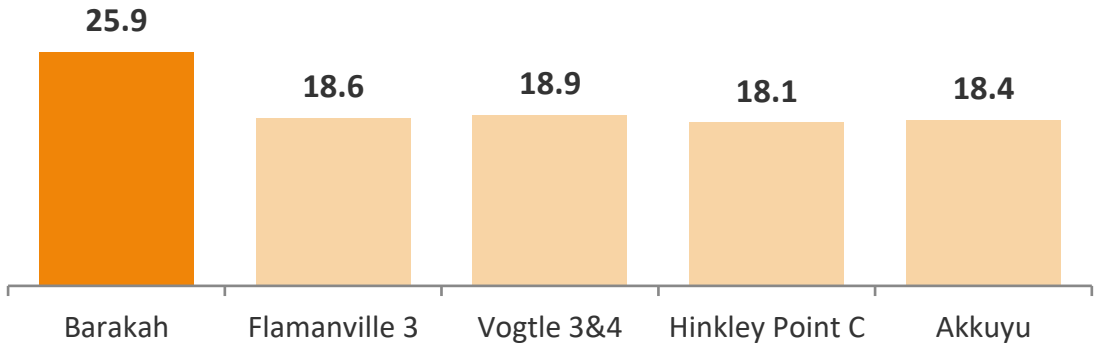
Least weighted: Domestic Company Capacity (1.96%).

Each structure's score by dimension

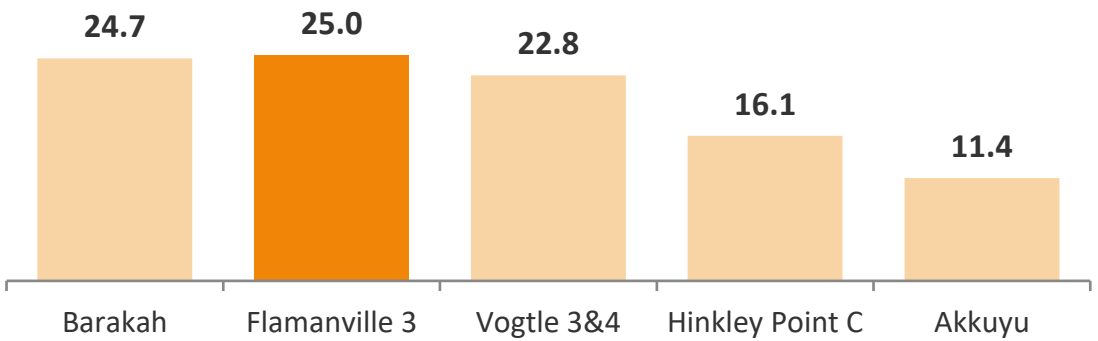
Project Entity Ownership (weight 16.6%)



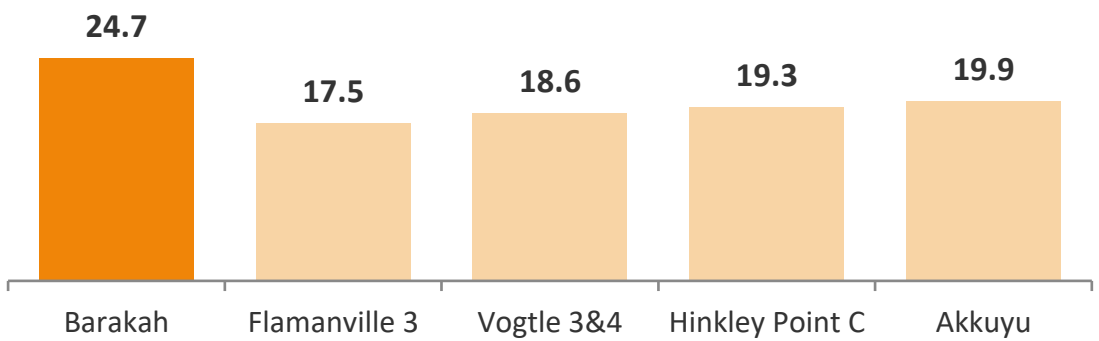
Contractual Risk Allocation (weight 16.9%)



Strategic National Value (weight 34.8%)



Financing Feasibility & Capital Cost (weight 31.8%)



FROM RATINGS TO SCORES

How a rating becomes a score

WHY RATE DIRECTLY?

- The five projects sit in very different historical, regulatory and market contexts, so comparing them pairwise is not meaningful.
- Each expert rates every case on every sub-criterion: 1 = fails to meet it, 9 = fully meets it with strong documentary evidence.
- The 19 ratings are pooled with a geometric mean.

Worked example: Alignment with National Energy Security (global weight 13.3%)

Alternative	Rating (geo-mean, 1–9)	Share of total	Contribution (pts)
Barakah	6.68	24.3%	**3.22**
Flamanville 3	6.66	24.2%	**3.21**
Vogtle 3&4	5.96	21.7%	**2.87**
Hinkley Point C	4.78	17.4%	**2.30**
Akkuyu	3.45	12.5%	**1.66**

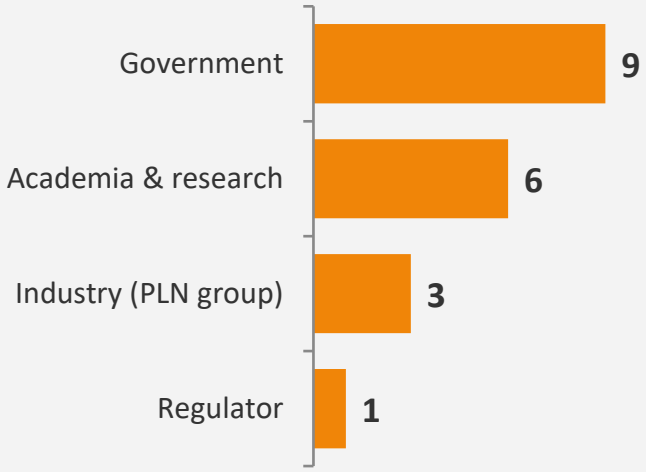
Priority score = Σ over 14 sub-criteria of (global weight × share of ratings)

Summed over all 14 sub-criteria, Barakah reaches 24.90%.

EXPERT PANEL & DATA QUALITY

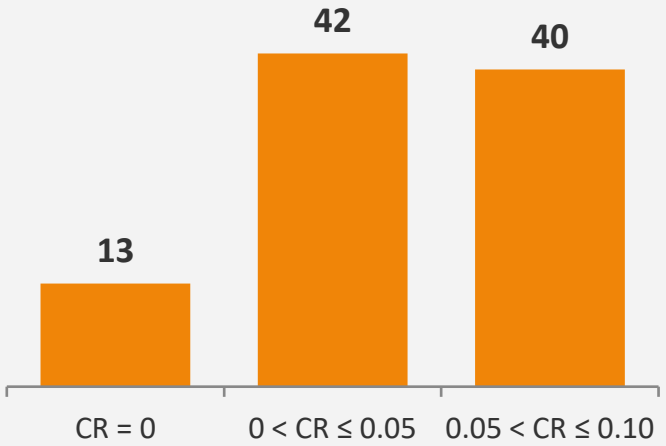
19 experts: coherent, but not unanimous

WHO: stakeholder groups (n = 19)



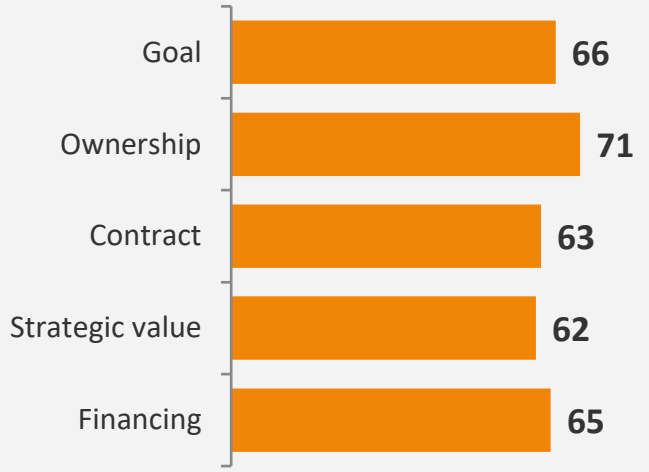
4 Grouped by affiliation.

CONSISTENCY: CR of 95 matrices



Maximum CR 0.0999. Consistency is within each expert, not between experts.

CONSENSUS: AHP-OS indicator (%)



Group agreement of about 65% on a 0–100% scale: experts differ in emphasis.

15 institutions: Academics, Industry practitioners, Government Officials, and the Nuclear Regulator. Data collected 26 June – 13 July 2026.

CASE STUDIES

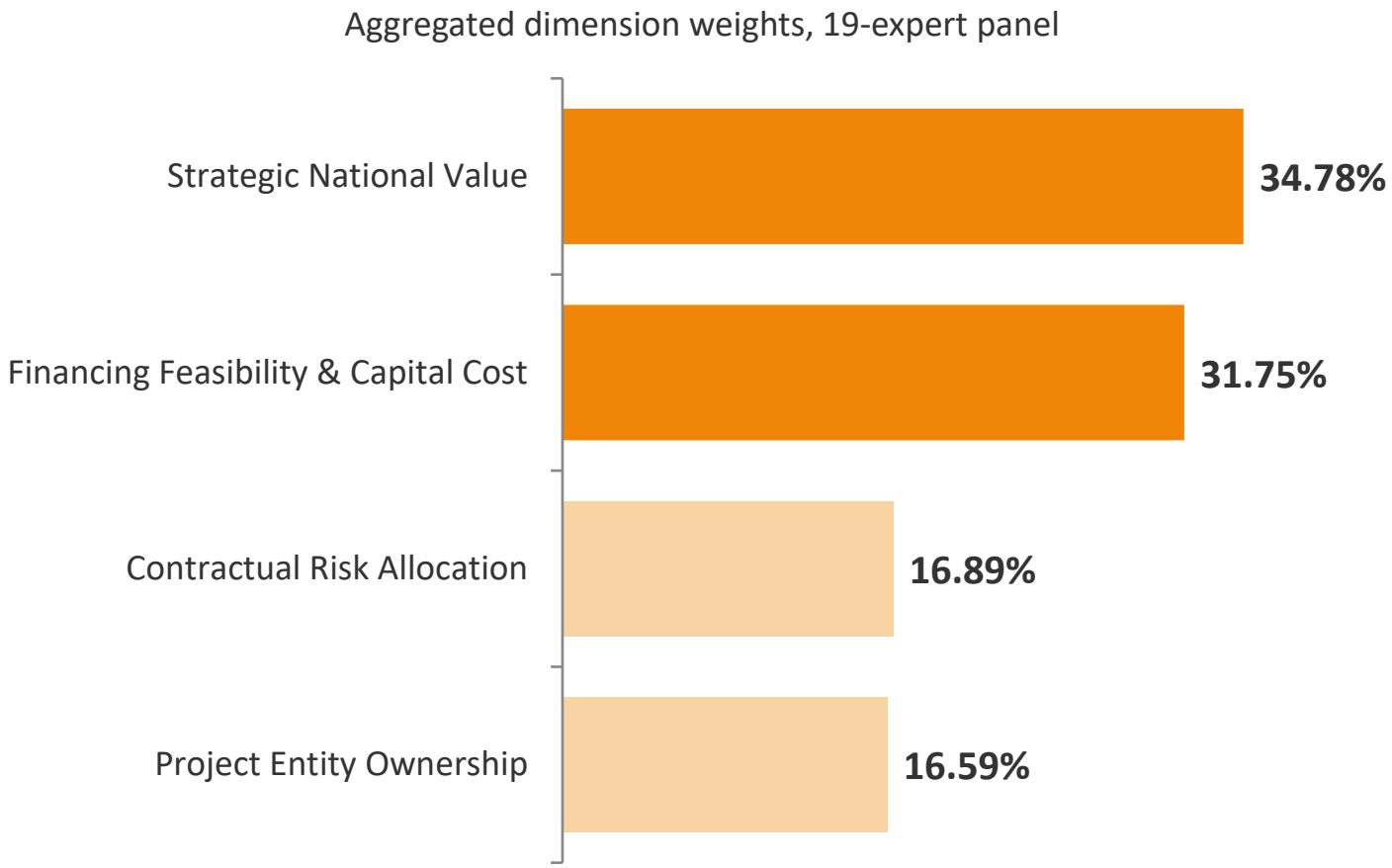
Five megaprojects, five structures

Case	Ownership model	Reported cost	Key lesson
Barakah, UAE	Public–Vendor JV (ENEC 82% / KEPCO 18%)	USD 20 B → 24.5 B	Fixed-price EPC and sovereign backing improve bankability
Hinkley Point C, UK	Foreign corporate JV (EDF 65% / CGN 35%)	GBP 31–34 B (2024 est.)	CfD secures revenue but not construction-cost risk
Akkuyu, Türkiye	Vendor-led BOO (100% Rosatom)	≈ USD 20 B (est.)	No upfront capital, but full vendor dependency
Vogtle 3&4, USA	Regulated utility consortium	USD 36.8 B (final)	CWIP shifts overrun risk to ratepayers
Flamanville 3, France	State utility (EDF) balance sheet	EUR 3.3 B → 23.7 B	No EPC risk transfer: the state absorbs FOAK overrun and delay

Costs as reported in the paper (references 17–24). Highlighted row: the structure ranked first in the AHP synthesis.

RESULT 1 · EXPERT WEIGHTS

Experts value strategy and financing most



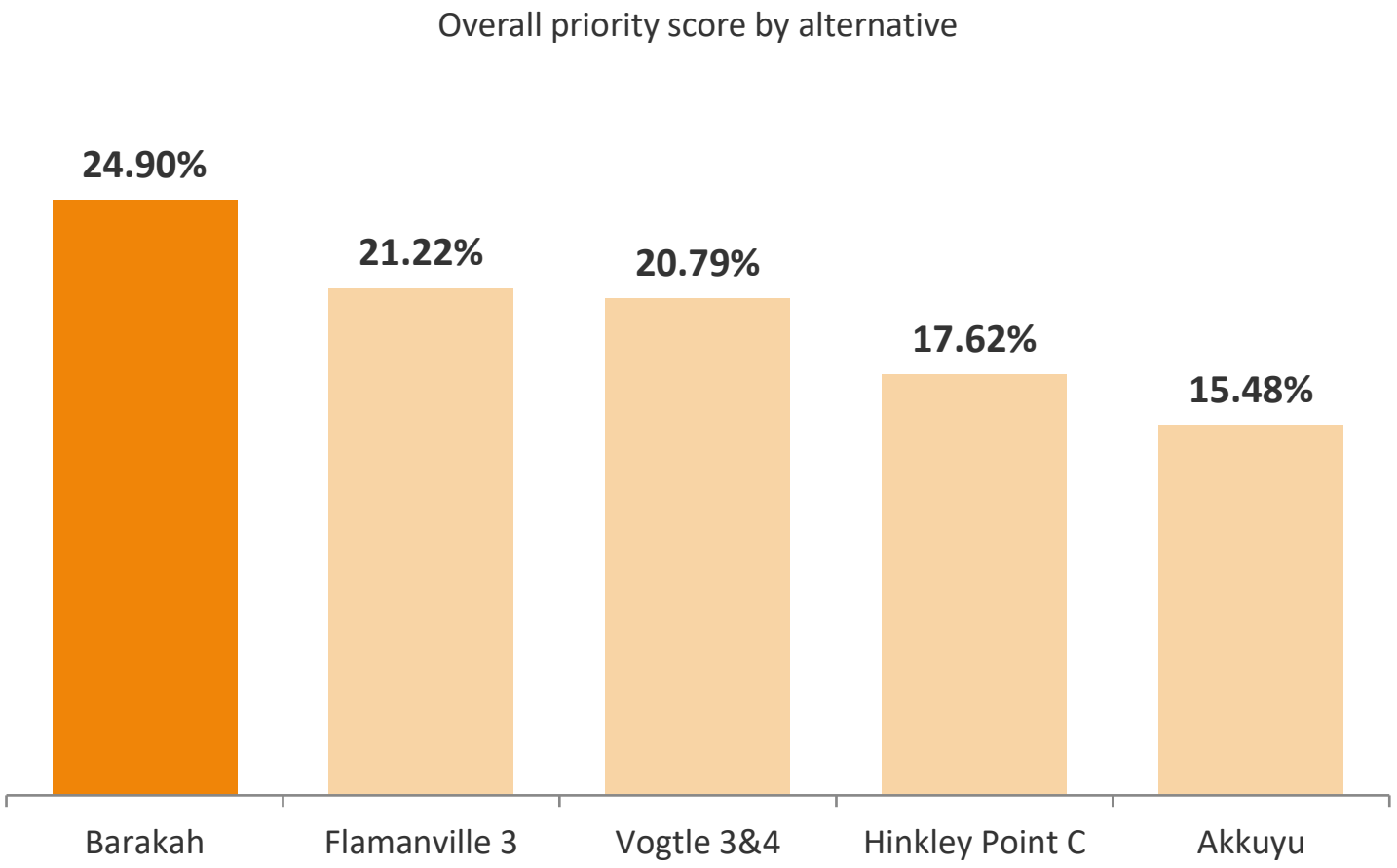
66.5%

of total weight sits on Strategic National Value and Financing Feasibility.

Ownership share ranks last. Contract and Ownership are a near tie (16.89% vs 16.59%): treat that order with caution.

RESULT 2 · OVERALL RANKING

The Public–Vendor JV ranks first



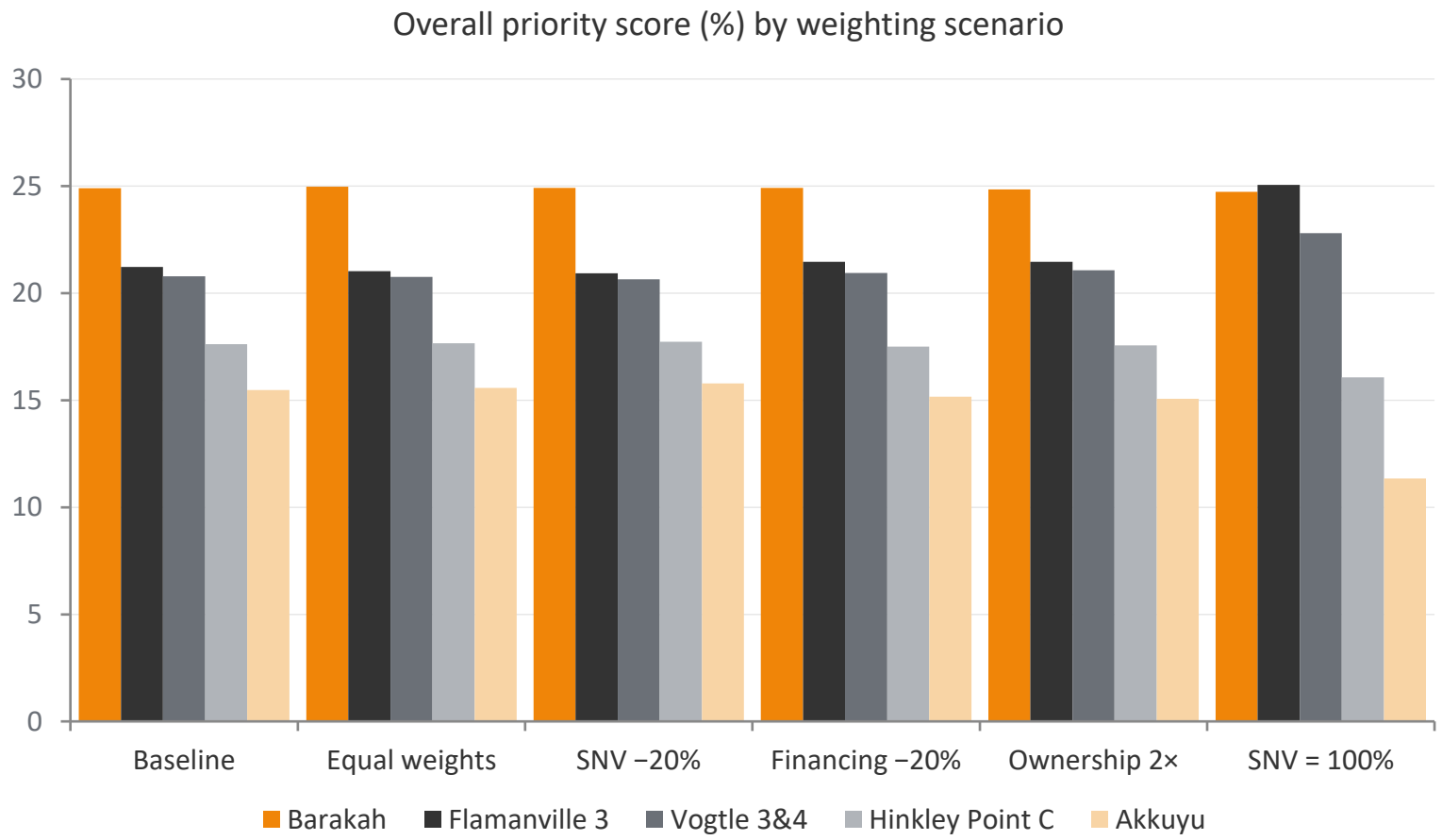
24.90%

Barakah's overall score: a Public–Vendor JV, ENEC 82% and KEPCO 18%.

- 3.7 points ahead of Flamanville 3
- Leads Ownership, Contract and Financing
- Vendor-led BOO (Akkuyu) ranks last at 15.48%

ROBUSTNESS

The ranking holds under stress tests

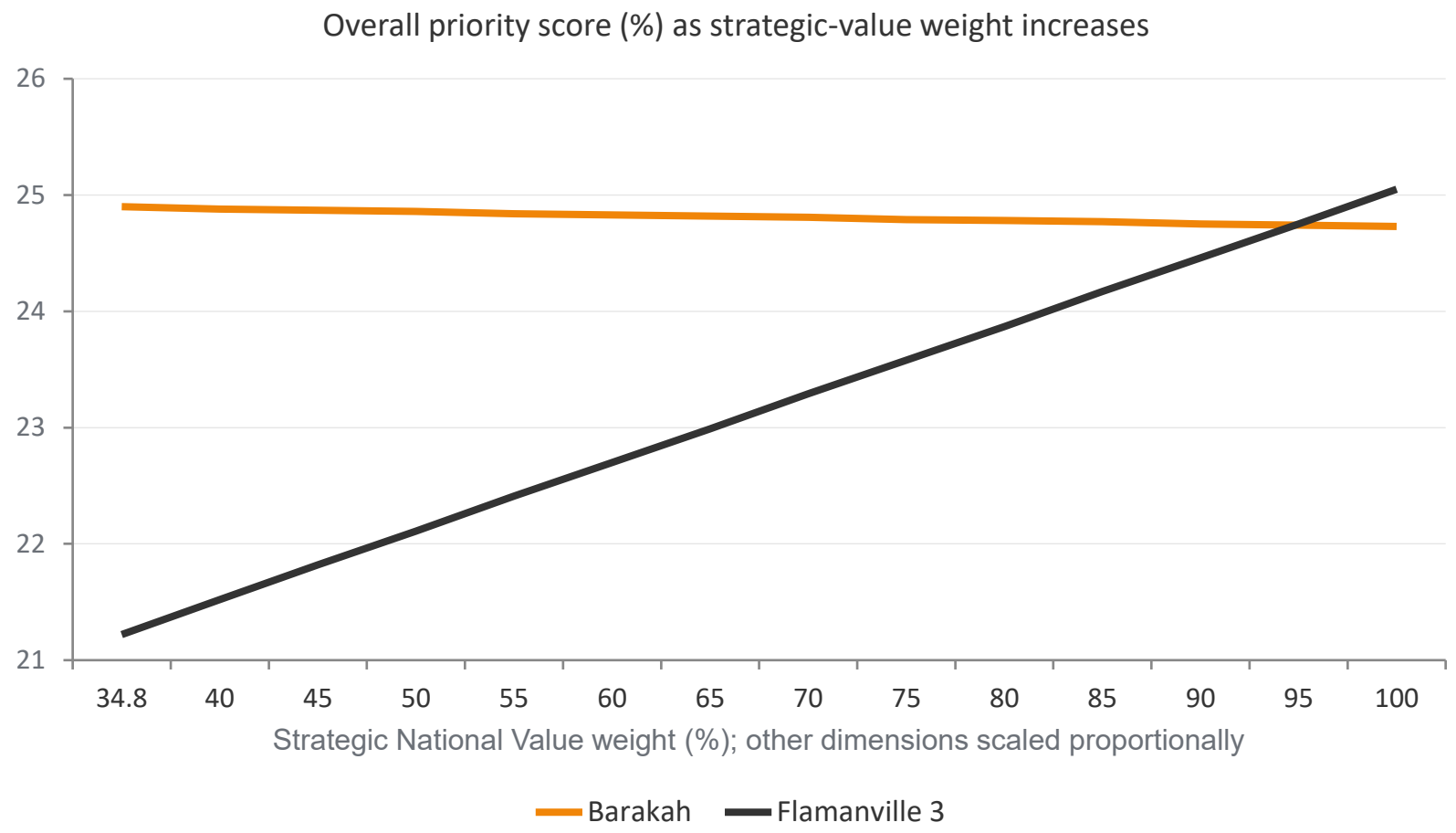


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scenarios keep Barakah first, with scores of 24.8–25.0%.

BACKUP · BREAKEVEN

How far must the weights move to flip it?



≈95%

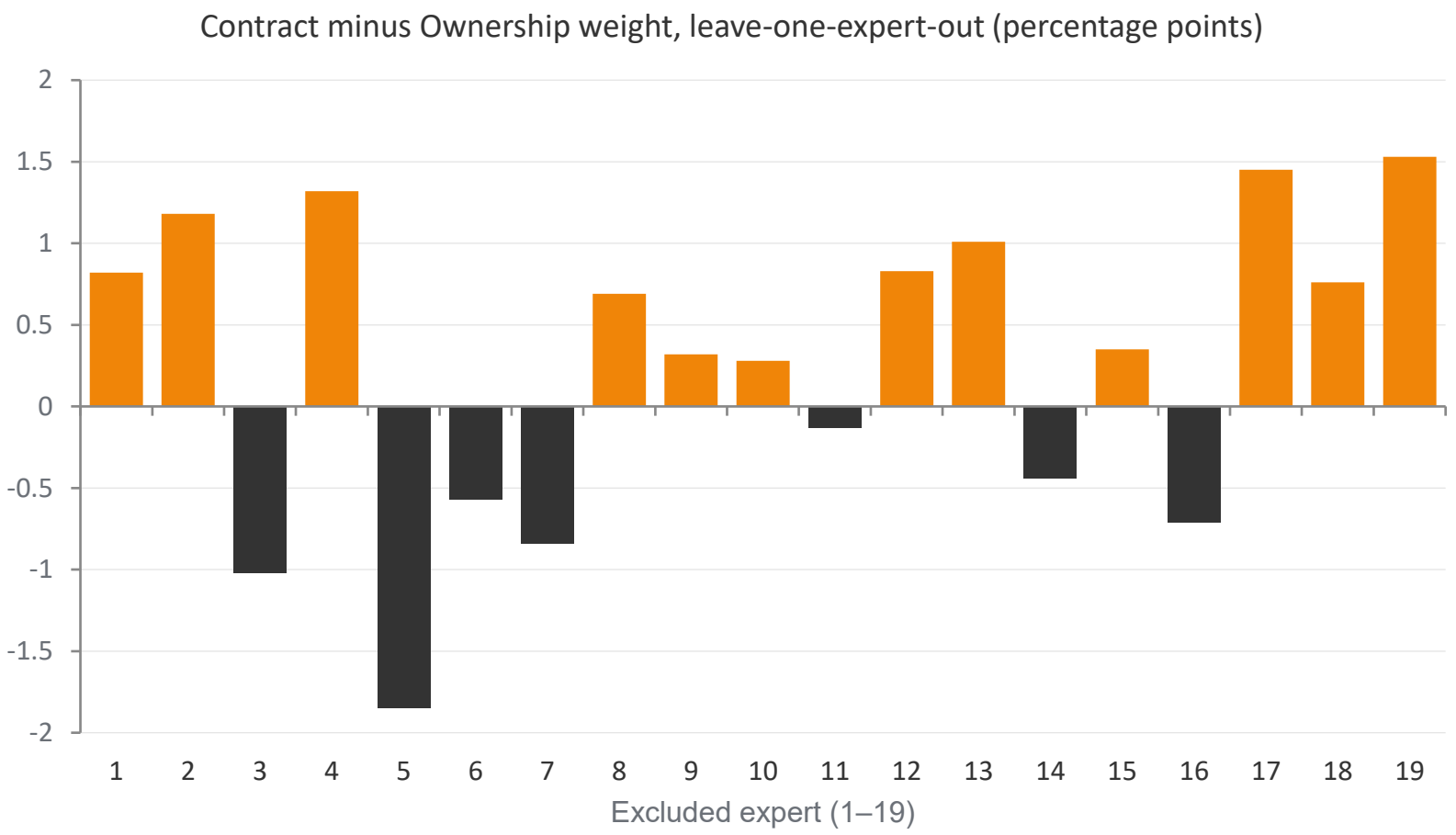
Group-weight path: crossover vs. 34.78% elicited.

78.0%

Respondent-level path (each expert's own weights and ratings): crossover vs. 34.4% elicited.

BACKUP · EXPERT DISAGREEMENT

Ownership vs. Contract: a statistical tie



7 of 19

exclusions reverse the order (experts 3, 5, 6, 7, 11, 14, 16; dark bars).

11 · 7 · 1

experts who weight Ownership higher, Contract higher, or equal. Official baseline: Contract 16.89% vs. Ownership 16.59%.

SCOPE OF CLAIMS

What the results do and don't say

THE RESULTS SHOW

- **Priorities.** Strategic value and financing carry 66.5% of the weight; their top-two order holds in 19 of 19 leave-one-out runs.
- **Preference.** Barakah's Public–Vendor JV ranks first at 24.90% and stays first in five of six weighting scenarios.
- **Breakeven.** Strategic value would need about 95% of total weight (78.0% by the respondent-level path) to flip the ranking.

THE RESULTS DO NOT SHOW

- **Infeasibility.** Other structures are not ruled out: scores are relative shares among five cases.
- **Contract vs. Ownership.** A tie: 11 experts weight Ownership higher, 7 the reverse, 1 equal; 7 of 19 exclusions flip the order.
- **Unanimity.** Consensus is about 65%, and individual strategic-value weights range from 5% to 56%.
- **Copy-paste.** No project transfers as is: Barakah relied on sovereign financing and Korean export-credit support.

POLICY IMPLICATIONS

What this means for Indonesia

Adopt a Public–Vendor JV

PT PLN, as state partner and sole off-taker, and the reactor vendor share the financing burden. The state keeps its policy levers, technology transfer and the BRIN innovation ecosystem.

Blend capital to lower WACC

Combine Danantara's sovereign capital with G2G loans and export-credit support. Lower discount rates are the realistic way to keep the tariff affordable.

Treat BOO as a trade-off

Vendor-led BOO removes the upfront capital need (2nd on financing), but means single-vendor dependence from design to waste management, at the cost of sovereignty.

Indonesia's sovereign credit profile (July 15, 2026)

	S&P Global	Fitch	Moody's
Rating	BBB	BBB	Baa2
Outlook	Stable	Negative	Negative

Investment-grade but under pressure: state-backed structures are fundamentally necessary.

WHAT TO REMEMBER

Key Contributions

1

A decision model for NPP structuring

Four dimensions and 14 sub-criteria compare ownership, contract, strategic value and financing in a single AHP model.

2

Indonesia's own priorities, measured

19 experts from 15 institutions weight Strategic National Value (34.78%) and Financing (31.75%) far above Ownership share (16.59%).

3

A robust first-ranked structure

The Public–Vendor JV (Barakah model) scores 24.90% and stays #1 under equal weights, ±20% shifts and 2× Ownership weight.

4

A policy path with explicit trade-offs

PLN plus vendor JV, Danantara capital with G2G and ECA support; BOO only if fiscal relief outweighs lost sovereignty.

Structure first, reactor second.

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