Cost-Benefit Analysis of Electricity Transition Pathways for the Maldives

A Policy Brief for Decision-Makers

International Initiative for Impact Evaluation (3ie)

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Executive Summary

! The Bottom Line

The Maldives can save over $2 billion by transitioning away from diesel power to renewable energy. The most cost-effective path is connecting to India's power grid while building a domestic inter-island electricity network.

0.1 The Challenge

The Maldives faces a triple energy crisis:

1. **Unsustainable costs**: The country spends over **$400 million per year** importing diesel fuel to generate electricity—money that leaves the economy permanently.
2. **Climate vulnerability**: As the world's lowest-lying nation, the Maldives is existentially threatened by climate change, yet currently generates **93% of electricity from fossil fuels**.
3. **Energy insecurity**: Complete dependence on imported diesel means global oil price shocks directly impact Maldivian households and businesses.

0.2 What We Analyzed

This study evaluated four different pathways for the Maldives' electricity future over a 30-year period (2026-2056):

Pathway	What It Means
Business as Usual (BAU)	Keep using diesel generators with minimal change
Full Integration	Build an undersea cable to India + connect all islands + add solar
National Grid	Connect all islands with undersea cables + add solar (no India link)
Islanded Green	Install solar panels and batteries on each island separately

0.3 The Key Finding

In plain terms: If the Maldives continues relying on diesel ("Business as Usual"), the electricity system will cost approximately **$5.3 billion** over the next 30 years. By contrast, connecting to India and building a national grid ("Full Integration") would cost only **$3.1 billion**—a savings of **$2.2 billion**.

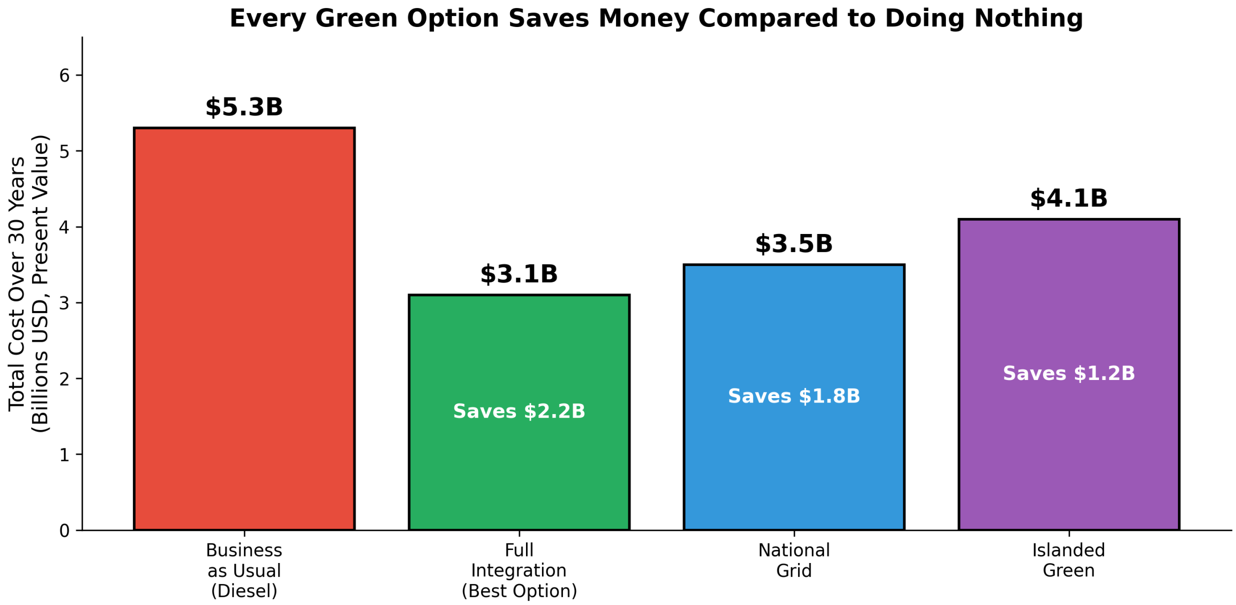

Figure 1: 30-Year Cost Comparison: Doing Nothing vs. Going Green

0.4 Recommendations for Policymakers

Our Three Key Recommendations

1. **Pursue negotiations with India immediately** for the undersea cable connection. This is the single most impactful decision available.
2. **Begin planning the inter-island grid** as this benefits all scenarios and can proceed in parallel with India negotiations.
3. **Expand solar PV installations** on all islands now—this is a “no regrets” investment that benefits every pathway.

Chapter 1

Introduction: Why This Matters

1.1 The Maldives Energy Story

The Republic of Maldives is a nation of striking contradictions. Its pristine beaches and crystal waters attract millions of tourists, yet behind this paradise lies an energy system that threatens both its economy and its very existence.

Here are the uncomfortable truths:

- The Maldives generates **93% of its electricity from imported diesel fuel**
- Electricity costs Maldivians **$0.25-0.35 per kilowatt-hour**—among the highest rates in South Asia
- The country imports **over 400,000 tonnes of diesel annually**, creating massive foreign exchange outflows
- Despite being at the forefront of climate change advocacy, the nation's electricity sector emits approximately **1.2 million tonnes of CO per year**

This situation is economically wasteful, environmentally destructive, and entirely fixable.

1.2 Why a Transition Is Urgent

Several factors make 2026 a critical decision point:

1. **Falling renewable energy costs**: Solar panels now cost 90% less than in 2010. Battery storage costs have fallen 80% since 2015. These technologies are now cheaper than diesel in most applications.
2. **Rising fuel costs**: Global diesel prices remain volatile, and the long-term trend points upward as extraction becomes more difficult and carbon prices emerge.
3. **Regional opportunities**: India is actively seeking to expand electricity exports, and neighboring countries are building grid connections. The Maldives risks being left behind.
4. **Climate commitments**: The Maldives has pledged net-zero emissions by 2030—an ambitious target that requires immediate action in the power sector.

1.3 Purpose of This Analysis

This cost-benefit analysis provides Cabinet-level decision-makers with a clear, evidence-based comparison of four electricity pathways. We have calculated the full lifecycle costs and benefits of each option over 30 years, accounting for:

- Capital investments (building power plants, cables, batteries)

- Ongoing operational costs (maintenance, staffing)
- Fuel and electricity import costs
- Environmental benefits (avoided carbon emissions)
- Energy security implications

The goal is simple: **identify which pathway delivers reliable, affordable, clean electricity at the lowest total cost to the nation.**

Chapter 2

Understanding the Geography

Before examining the options, it helps to understand the unique geographic challenge the Maldives faces.

2.1 Map of the Maldives

The figure below shows all inhabited islands of the Maldives. Each circle represents an island, sized by population and colored by solar energy potential (darker red = higher potential). The dashed lines show proposed grid infrastructure.

2.2 The Geographic Challenge

The Maldives presents a unique infrastructure challenge:

- **40 inhabited islands** spread across the Indian Ocean
- **860 kilometers** from the northernmost to southernmost island
- **336,677 people** to serve with electricity
- **Average solar irradiance of 5.6 kWh/m²/day**—among the best in the world for solar power

This geography explains why the Maldives currently relies on diesel: it was simply too expensive to connect scattered islands with cables, so each island got its own diesel generator. But technology costs have changed dramatically, and this analysis shows that interconnection is now the smarter choice.

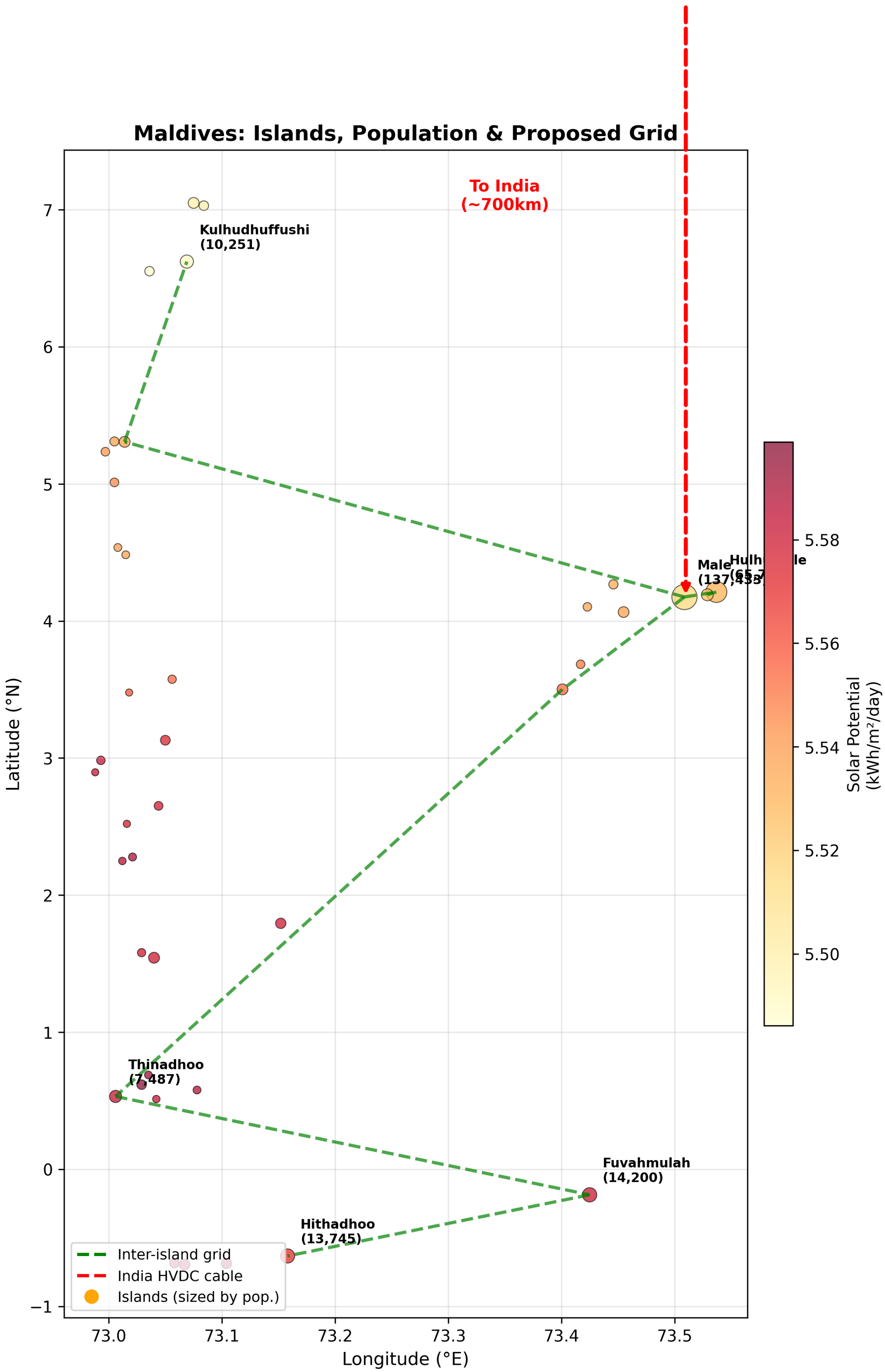

Figure 2.1: Maldives Islands: Population Centers and Proposed Grid Infrastructure

Chapter 3

The Four Pathways Explained

This section explains each of the four options in plain language, including what investments they require and what they would mean for everyday Maldivians.

3.1 Pathway 1: Business as Usual (BAU)

> What BAU Means
>
> Keep doing what we're doing: run diesel generators on each island with minimal investment in alternatives.

What happens under BAU:

- Diesel generators continue operating on each island
- Only minimal solar additions (staying at ~7% renewable)
- No new undersea cables or grid connections
- Continued import of 400,000+ tonnes of diesel annually

The costs:

- Over **$10 billion in fuel costs** over 30 years
- Electricity prices remain high ($0.30+/kWh)
- Complete exposure to oil price volatility
- **26.5 million tonnes of CO_2 emissions**

Who wins, who loses:

- Diesel importers and generator manufacturers benefit from continued business
- Consumers pay the highest electricity rates
- The environment and climate continue to suffer
- Foreign exchange reserves drain to pay for fuel imports

The bottom line: BAU is the most expensive option. It only looks cheap because it requires no new investment decisions—but the fuel bills will be massive.

3.2 Pathway 2: Full Integration (Recommended)

What Full Integration Means

Build an undersea cable to India, connect Maldivian islands together, and add solar panels everywhere possible.

What this requires:

1. **India-Maldives HVDC Cable** (~700 km): A high-capacity undersea cable connecting Male to the Indian power grid in Kerala. Estimated cost: **$1.4-2.1 billion**
2. **Inter-Island Grid**: Submarine cables connecting major population centers from Addu in the south to Haa Alif in the north. Estimated cost: **$500-800 million**
3. **Solar PV Expansion**: Rooftop and ground-mounted solar across all islands, reaching 70% renewable by 2050. Estimated cost: **$800 million - $1.2 billion**
4. **Battery Storage**: Utility-scale batteries to manage solar intermittency. Estimated cost: **$200-400 million**

The benefits:

- **Lowest total cost**: $3.1 billion in present value vs $5.3 billion for BAU
- **Cheapest electricity**: $0.18/kWh—nearly half the BAU cost
- **Energy security**: Diverse supply from India, domestic solar, and batteries
- **Minimal emissions**: Only 6.5 million tonnes CO (75% reduction)

The risks:

- Requires diplomatic agreement with India
- Large upfront investment needed
- Dependence on a single external supplier

Who wins, who loses:

- Consumers get significantly lower electricity bills
- Businesses benefit from reliable, affordable power
- Climate benefits from massive emissions reduction
- Job creation in solar installation and grid maintenance
- Diesel importers lose business (but this is good for the economy)
- Some dependence on India (mitigated by domestic solar)

3.3 Pathway 3: National Grid

What National Grid Means

Connect all Maldivian islands together with undersea cables and add solar—but without the India connection.

What this requires:

- **Inter-Island Grid**: Same as Full Integration
- **Larger Solar Deployment**: Without India imports, more domestic solar needed
- **More Battery Storage**: Greater storage requirements for reliability
- **Some Diesel Backup**: Retained for periods of low solar/high demand

The benefits:

- **Energy independence**: No reliance on foreign power suppliers
- **Still saves money**: $3.5 billion vs $5.3 billion BAU
- **Major emissions reduction**: 11.3 million tonnes CO

The downsides:

- **Higher cost than Full Integration**: $370 million more expensive
- **Higher LCOE**: $0.22/kWh vs $0.18/kWh
- **More technical complexity**: Larger battery systems needed

When to choose National Grid:

This pathway makes sense if:

- India negotiations fail or face unacceptable terms
- Energy sovereignty is the top political priority
- Regional geopolitics make external dependence risky

3.4 Pathway 4: Islanded Green

> What Islanded Green Means
>
> Install solar panels and batteries on each island separately—no underwater cables at all.

What this requires:

- **Solar PV on every island**: Significant installations on all 40+ inhabited islands
- **Large battery systems**: Each island needs enough storage for cloudy days and nighttime
- **Diesel backup**: Retained on each island for reliability
- **No grid infrastructure**: No inter-island or India cables

The benefits:

- **Maximum resilience**: Each island operates independently
- **No cable vulnerability**: No risk of undersea cable damage
- **Faster implementation**: Can start immediately without major infrastructure

The downsides:

- **Most expensive green option**: $4.1 billion vs $3.1 billion for Full Integration
- **Less efficient**: No ability to share power between islands
- **Higher emissions**: 14 million tonnes CO (more diesel backup needed)
- **Scalability challenges**: Harder to add capacity as demand grows

When to choose Islanded Green:

This pathway makes sense if:

- Grid infrastructure is absolutely not feasible
- Speed of initial deployment is the top priority
- Islands want complete energy autonomy

Chapter 4

Comparing the Costs

4.1 The Big Picture

Let's break down where the money goes under each scenario:

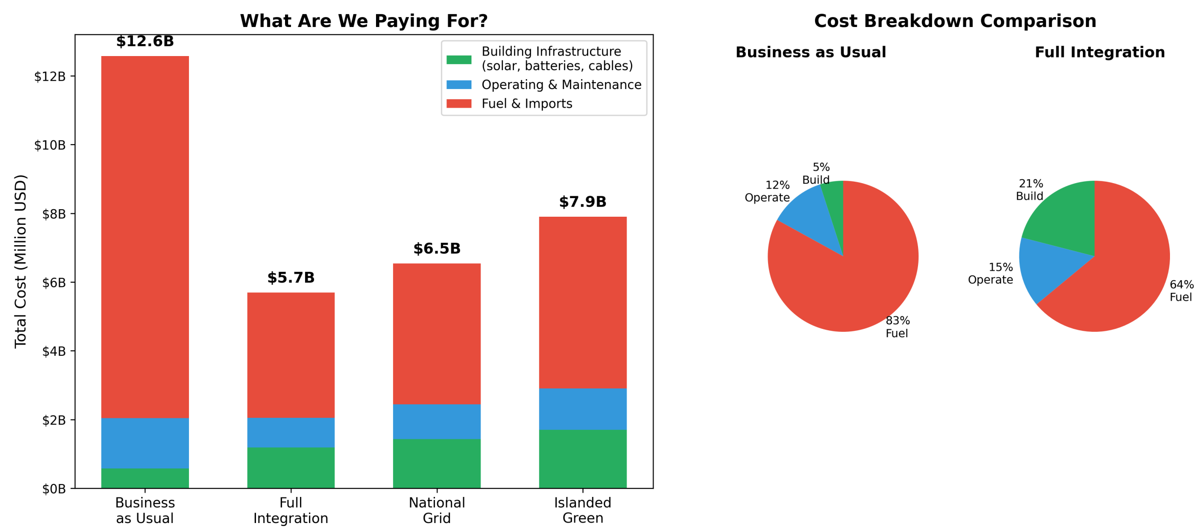

Figure 4.1: Where Does the Money Go? Total 30-Year Costs by Category

The key insight: Under BAU, **83% of all spending goes to fuel**—money that leaves the Maldivian economy entirely. Under Full Integration, while upfront investment is higher, fuel costs drop dramatically, and much of the spending stays in the domestic economy.

4.2 What Do Consumers Pay?

The **Levelized Cost of Electricity (LCOE)** tells us what electricity actually costs per kilowatt-hour:

In practical terms:

- A household using 300 kWh/month currently pays about **$75/month** for electricity
- Under Full Integration, that same household would pay about **$54/month**—a savings of **$21/month or $252/year**
- Across the Maldives, this represents hundreds of millions of dollars in annual household savings

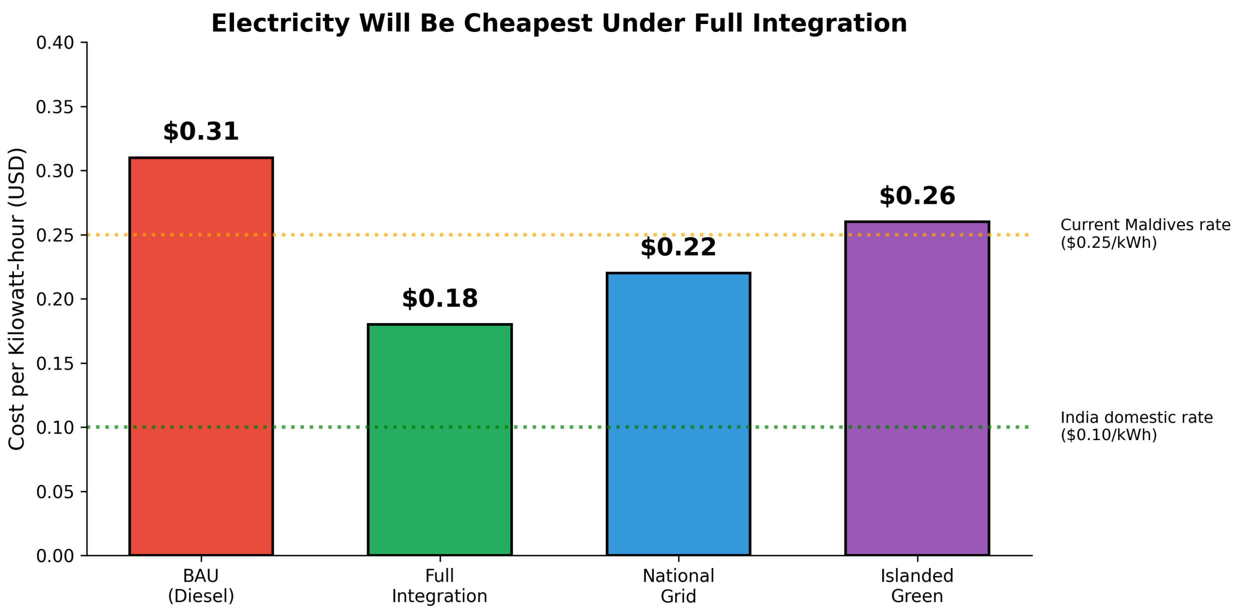

Figure 4.2: What Will Electricity Cost? ($ per kilowatt-hour)

Chapter 5

The Climate Dimension

5.1 Why Emissions Matter

The Maldives is among the countries most vulnerable to climate change. Rising sea levels pose an existential threat to the nation. Yet the electricity sector is also the largest source of domestic greenhouse gas emissions.

Reducing emissions serves two purposes:

1. **Moral leadership**: The Maldives has been a global advocate for climate action. Cleaning up its own power sector strengthens this advocacy.
2. **Practical benefits**: Each tonne of CO avoided has real economic value. Using the US EPA's "social cost of carbon" of **$190 per tonne**, avoided emissions represent tangible benefits.

5.2 Emissions by Scenario

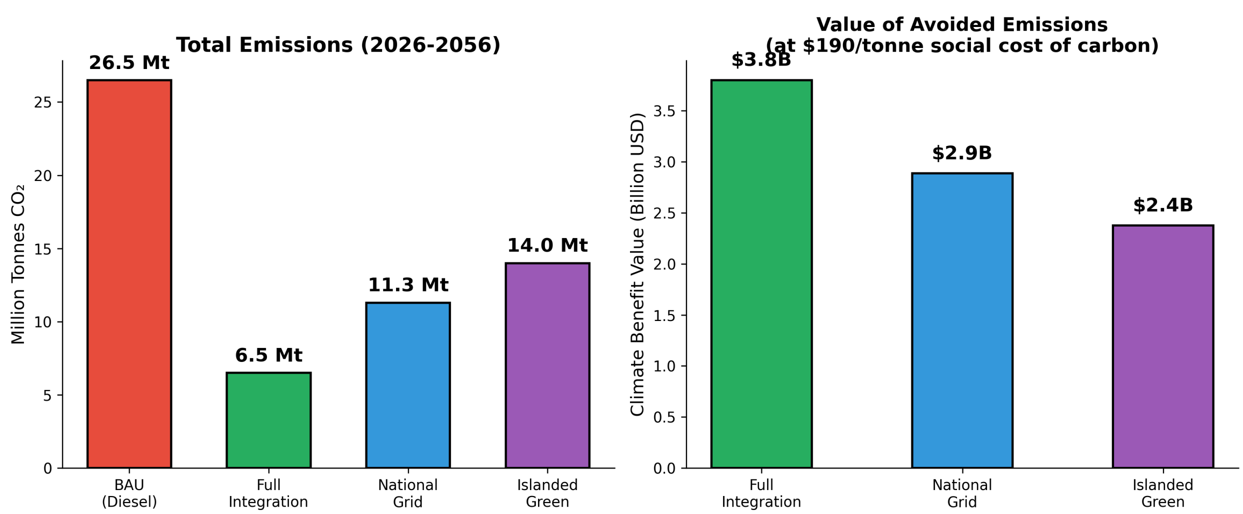

Figure 5.1: Cumulative CO Emissions Over 30 Years (Million Tonnes)

The climate benefit is worth billions. Using internationally recognized carbon values:

- Full Integration avoids **20 million tonnes of CO**, worth approximately **$3.8 billion**
- Even the most modest green scenario (Islanded Green) avoids **12.5 million tonnes**, worth **$2.4 billion**

These climate benefits alone justify the upfront investment in clean energy infrastructure.

Chapter 6

How Robust Are These Results?

Policymakers rightly ask: “What if your assumptions are wrong?” We tested this extensively.

6.1 Key Uncertainties

The analysis depends on several uncertain parameters:

Parameter	Our Assumption	Could Be Lower	Could Be Higher
Diesel price	$0.85/liter	$0.60/L	$1.10/L
Solar panel cost	$750/kW	$550/kW	$1,000/kW
Battery cost	$150/kWh	$100/kWh	$250/kWh
India import price	$0.06/kWh	$0.04/kWh	$0.10/kWh
Cable cost	$3M/km	$2M/km	$4M/km
Discount rate	6%	3%	10%

6.2 The Robustness Test

We ran the model 1,000 times with randomly varying parameters to see how often each scenario “wins”:

> **!** Key Finding: BAU Never Wins
>
> Across 1,000 random simulations with varying assumptions, **Business as Usual was never the least-cost option**. Not once.
> This means that regardless of how diesel prices, solar costs, or other factors evolve, doing nothing is always the worst choice economically.

6.3 Switching Points

We also calculated what it would take for different scenarios to become preferred:

- **For BAU to beat Full Integration**: Diesel would need to fall to **$0.25/liter**—well below any historical low. This is effectively impossible.
- **For National Grid to beat Full Integration**: India’s import price would need to exceed **$0.11/kWh**—possible but unlikely given current market prices of $0.05-0.06.

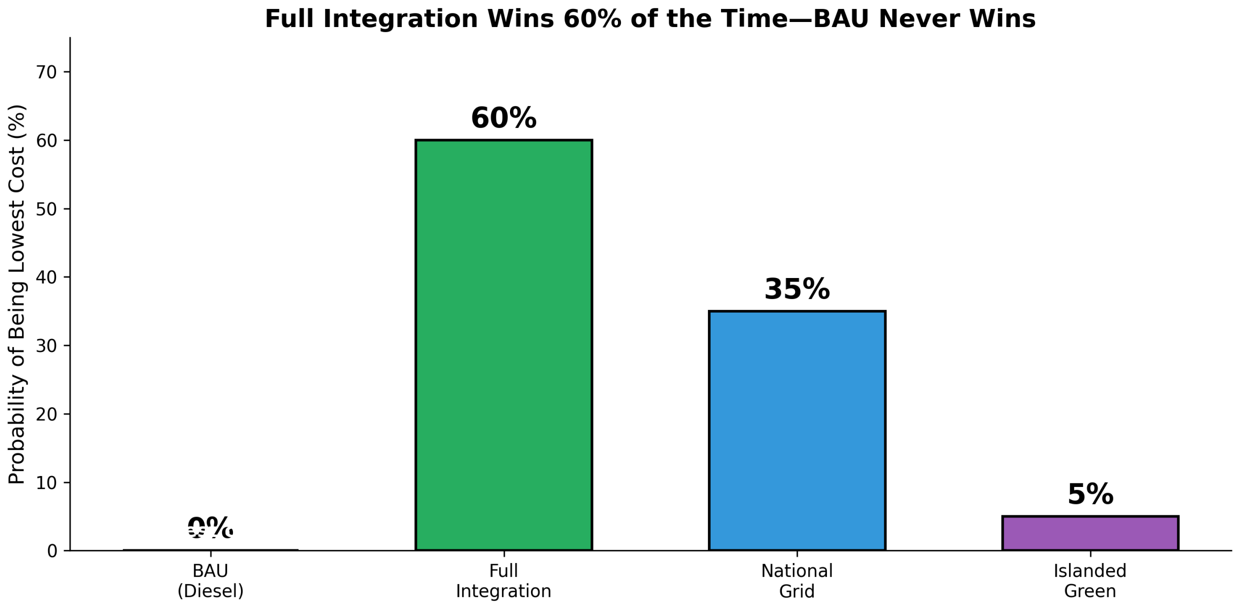

Figure 6.1: How Often Does Each Scenario Win? (Based on 1,000 Simulations)

- **For Islanded Green to beat National Grid**: This would require cable costs to triple—unlikely given engineering advances.

Chapter 7

Implementation Roadmap

If policymakers choose the recommended Full Integration pathway, here is a realistic timeline:

7.1 Phase 1: Immediate Actions (2026-2028)

Year 1 (2026):

- Begin diplomatic negotiations with India on power purchase agreement
- Commission detailed feasibility study for India-Maldives cable
- Start procurement for initial 100 MW solar installations on larger islands
- Establish regulatory framework for power purchase agreements

Years 2-3 (2027-2028):

- Finalize cable route and environmental impact assessments
- Award construction contracts for inter-island grid Phase 1 (Greater Malé region)
- Complete first 100 MW of solar installations
- Begin battery storage procurement

7.2 Phase 2: Major Construction (2029-2032)

Years 4-7:

- Construct India-Maldives HVDC cable
- Build inter-island grid connecting major population centers
- Expand solar to 300 MW capacity
- Install 200 MWh battery storage

Key Milestone (2032): India cable operational, enabling electricity imports

7.3 Phase 3: Full Deployment (2033-2040)

Years 8-15:

- Complete inter-island grid to all inhabited islands
- Expand solar to 600+ MW
- Reach 70% renewable energy share
- Phase out most diesel generation

7.4 Investment Schedule

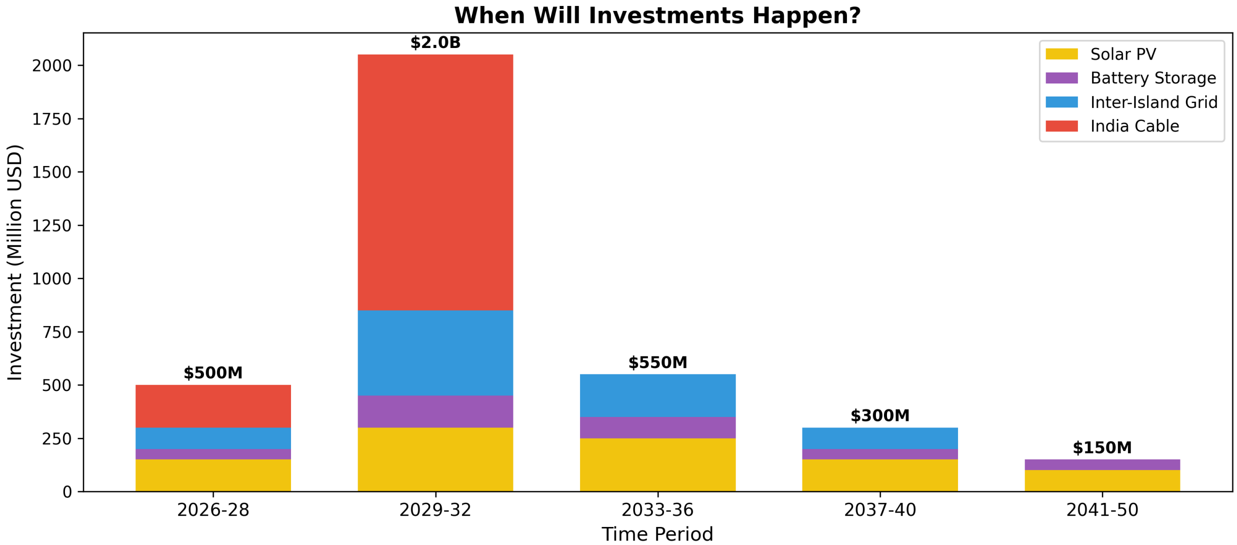

Figure 7.1: Investment Schedule for Full Integration Pathway

Chapter 8

Financing Considerations

8.1 Total Investment Required

The Full Integration pathway requires approximately **$4.5 billion** in capital investment over 15 years:

- **India-Maldives Cable**: $1.4-2.1 billion
- **Inter-Island Grid**: $500-800 million
- **Solar PV**: $800 million - 1.2 billion
- **Battery Storage**: $300-500 million

8.2 Potential Financing Sources

Source	Potential Contribution	Notes
Government of Maldives	$500M - $1B	Through budget allocation and state utility
India (concessional loan)	$500M - $1B	India has indicated interest in financing regional connectivity
Green Climate Fund	$200-500M	Maldives is eligible as a SIDS
World Bank / ADB	$500M - $1B	Infrastructure lending programs
Private Sector (IPP)	$500M - $1B	For solar PV through power purchase agreements

8.3 Return on Investment

Despite the large upfront cost, the return is compelling:

- **Net Present Value**: $2.2 billion in savings vs BAU
- **Payback Period**: Approximately 8-10 years

- **Benefit-Cost Ratio**: 4.5:1 (every $1 invested returns $4.50 in benefits)

Chapter 9

Risks and Mitigation

9.1 Key Risks

Risk	Likelihood	Impact	Mitigation
India negotiations fail	Medium	High	Fall back to National Grid pathway
Cable cost overruns	Medium	Medium	Use fixed-price contracts; contingency budget
Construction delays	Medium	Medium	Maintain diesel backup capacity
India supply interruption	Low	High	Domestic solar provides 50%+ of supply
Technology obsolescence	Low	Low	Modular investments; proven technologies

9.2 The India Dependence Question

Some may worry about depending on India for electricity. This concern is valid but manageable:

1. **Diversified supply**: Even with the India cable, domestic solar will provide 50%+ of electricity by 2040.
2. **Market pricing**: Power will be purchased at market rates through commercial contracts, not political agreements.
3. **Strategic value**: India has strong incentives to maintain reliable supply—the cable demonstrates regional leadership.
4. **Fallback available**: If relations sour, the National Grid pathway remains viable.

Chapter 10

Conclusions and Recommendations

10.1 What We Learned

This analysis leads to five clear conclusions:

> **Conclusion 1: All Green Pathways Beat Business as Usual**
>
> There is no scenario where continuing with diesel is the smart choice. The question is not whether to transition, but how.

> **Conclusion 2: Full Integration Offers the Best Value**
>
> Connecting to India while building a domestic grid delivers the lowest cost, lowest emissions, and acceptable energy security.

> **Conclusion 3: Results Are Robust to Uncertainty**
>
> Monte Carlo simulation confirms these findings hold even when key assumptions vary significantly.

> **Conclusion 4: The Climate Benefits Are Massive**
>
> Avoided emissions of 20 million tonnes of CO_2 have real economic value and strengthen the Maldives' moral leadership on climate.

> **Conclusion 5: Action Now Is Essential**
>
> Delaying only increases costs and extends diesel dependence. Every year of inaction costs approximately $100 million in lost savings.

10.2 Our Recommendations

For the Cabinet:

1. **Authorize negotiations with India** on the HVDC cable project immediately. This is the single highest-value decision available.

2. **Approve funding** for detailed feasibility studies and environmental assessments for both the India cable and inter-island grid.
3. **Direct STELCO** to begin procurement for 100 MW of new solar PV installations on major islands.

For the Ministry of Finance:

4. **Engage multilateral development banks** and the Green Climate Fund to secure concessional financing.
5. **Develop a financing strategy** that minimizes sovereign debt impact while mobilizing private capital.

For the Ministry of Foreign Affairs:

6. **Elevate energy cooperation** in bilateral discussions with India, positioning the cable as a flagship regional connectivity project.

For STELCO:

7. **Begin grid modernization** planning to enable future interconnection.
8. **Phase out diesel subsidies** gradually to create accurate price signals for investment.

Chapter 11

Technical Appendix

11.1 Model Parameters

For completeness, the key parameters used in this analysis are:

Table 11.1: Key Model Parameters

	Parameter	Value	Source
0	Base Year	2026	Study assumption
1	Analysis Horizon	30 years	Standard infrastructure analysis
2	Discount Rate	6% real	World Bank recommendation for SIDS
3	Diesel Price (2026)	$0.85/liter	Platts, December 2025
4	Diesel Price Escalation	2%/year	IEA World Energy Outlook 2025
5	Solar PV CAPEX (2026)	$750/kW	IRENA Renewable Power Generation Costs 2024
6	Battery CAPEX (2026)	$150/kWh	BloombergNEF Battery Price Survey Dec 2025
7	Inter-Island Cable Cost	$3 million/km	Industry quotes; Basslink precedent
8	India Import Price	$0.06/kWh + $0.01 transmission	India Energy Exchange spot market
9	Social Cost of Carbon	$190/tonne CO	US EPA 2023 (Rennert et al.)
10	Base Demand (2026)	1,100 GWh/year	IRENA Maldives Renewable Readiness 2024
11	Demand Growth Rate	5%/year	UNDP/STELCO projections

11.2 Data Sources

This analysis draws on data from:

- **IRENA** (International Renewable Energy Agency) - renewable energy costs and Maldives assessments
- **BloombergNEF** - battery price projections
- **World Bank** - discount rate guidance for developing countries
- **STELCO** (State Electric Company) - current system data
- **Global Solar Atlas** - island-level solar resource data
- **India Energy Exchange** - power market prices
- **US Environmental Protection Agency** - social cost of carbon

Chapter 12

References