

# Scenario-Based Assessment of Supply–Demand Balance in Uzbekistan's Electricity System to 2040

Aziza Shonazarova | Model-based Energy Analyst, JNKE – Uzbekistan Country Unit

# 1. Background & Context

## Uzbekistan's Energy System (2024)

- Gas-fired TPPs: ~83% of total generation (67 of 81.3 bn kWh)
- Installed capacity: 18.5 GW at end-2024
- Hydropower: ~10% of supply
- Solar: 6x growth in 2024 → ~4,000 GWh commissioned
- Wind: 790 GWh (vs 7 GWh in 2023)

## Key Policy Targets

- Uzbekistan 2030 Strategy: 40% renewables in electricity
- NDC: -35% GHG intensity vs 2010 by 2030
- DP-63 (Mar 2025): 20–40% subsidy for rooftop PV
- RP-100 (Mar 2025): -20% gas per residential unit
- New Uzbekistan Strategy: EV incentives & rail electrification

## Gas Supply Gap — Structural Challenge

| Indicator            | 2022 | 2023 | 2024 |
|----------------------|------|------|------|
| Production (bcm)     | 51.6 | 46.7 | ~46  |
| Consumption (bcm)    | ~50  | 52.1 | 52.1 |
| Net balance (bcm)    | +1.6 | -5.4 | ~-6  |
| Gas imports (USD bn) | ~0.7 | ~0.7 | 1.68 |

## Structural energy challenge:

- Net gas importer since 2023 (Russia & Turkmenistan)
- Power sector consumed 8.6 bcm gas in 2024
- Aging plants: 25–35% thermal efficiency only
- Gas import bill: USD 1.68 bn (2024)

# 2–3. Objective, Scope & Five Policy Measures

## Three-Level Model (Excel, 2023–2040)

- 1 **Annual**  
Supply-demand balance 2023–2040 by sector & source
- 2 **Monthly**  
Seasonal disaggregation — winter heating & summer cooling peaks
- 3 **Peak Day (July)**  
24-hour profile — critical stress window: 12–13h midday

## Five Policy Measures Modelled

|                                 |                                  |                               |                         |                                  |
|---------------------------------|----------------------------------|-------------------------------|-------------------------|----------------------------------|
| <b>M1</b><br>Utility-scale vRES | <b>M2</b><br>Electricity Imports | <b>M3</b><br>New Gas Capacity | <b>M4</b><br>Rooftop PV | <b>M5</b><br>Transport EV Demand |
|---------------------------------|----------------------------------|-------------------------------|-------------------------|----------------------------------|

## Five Research Questions

- S0 Deficit trajectory without any new action?
- S1 What can demand-side measures achieve alone?
- S2/S2a What does gas-led adequacy deliver?
- S3 Can renewables + imports close gap without gas?
- S4/S5 Full package: what does it achieve + import role?

# 3.5. Scenario Design Matrix

| Scenario                       | M1 vRES | M2 Import | M3 Gas | M4 Roof PV | M5 EV | Key Analytical Question                                |
|--------------------------------|---------|-----------|--------|------------|-------|--|
| <b>S0 — Baseline</b>           | —       | —         | —      | —          | —     | Deficit trajectory without new measures                |
| <b>S1 — Demand-side</b>        | —       | —         | —      | ■          | ■     | What do demand-side measures achieve alone?            |
| <b>S2 — Gas-led</b>            | —       | —         | ■      | —          | —     | What does gas-only supply expansion deliver?           |
| <b>S2a — Gas + EV demand</b>   | —       | —         | ■      | —          | ■     | How much gas needed when EV demand also grows?         |
| <b>S3 — Green Supply</b>       | ■       | ■         | —      | —          | —     | Can vRES + imports close the gap without gas?          |
| <b>S4 — Comprehensive</b>      | ■       | ■         | ■      | ■          | ■     | Full package: what does it achieve + import role?      |
| <b>S5 — Import Constrained</b> | ■       | —         | ■      | ■          | ■     | How critical are imports to the supply–demand balance? |

# 4. Baseline Scenario (S0): Widening Deficit

**76.6 TWh**

Demand, 2023

**137 TWh**

Demand by 2040

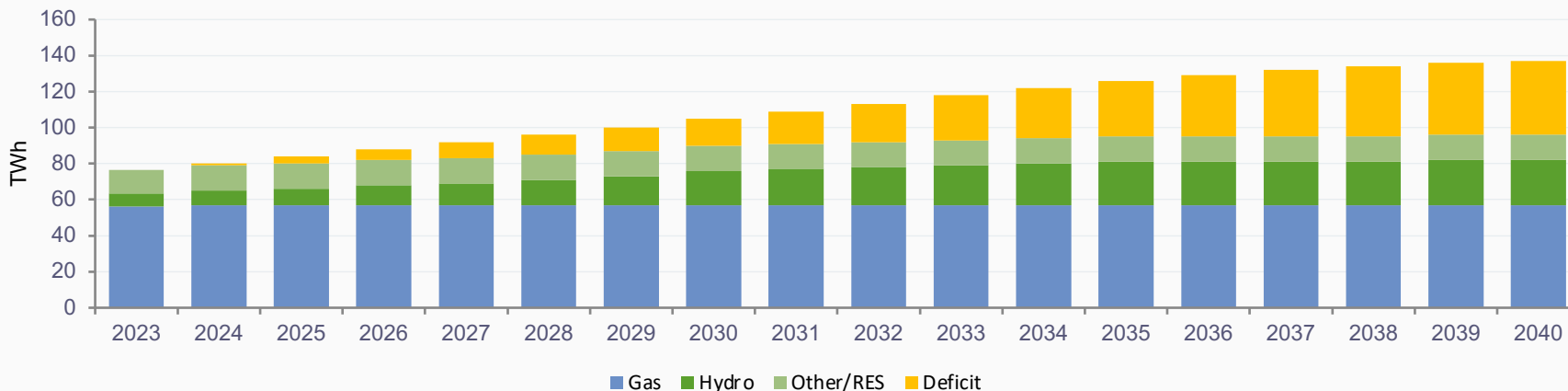
**34.1 TWh**

Deficit, 2040

**~25%**

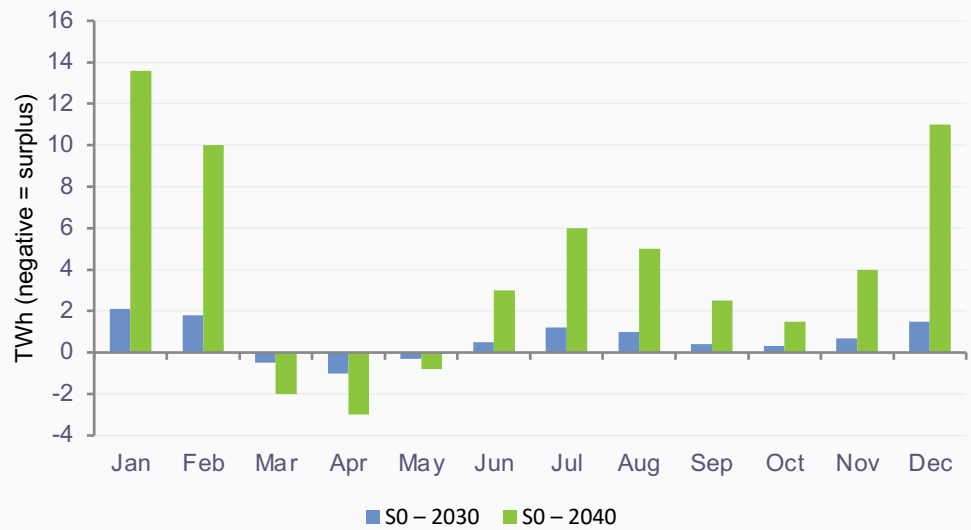
Deficit share

Annual Electricity Balance S0: Supply Components + Deficit(TWh)



# 4.2–4.3. Seasonal Patterns & Monthly Deficit

Monthly Deficit: S0 Baseline (2030 vs 2040)

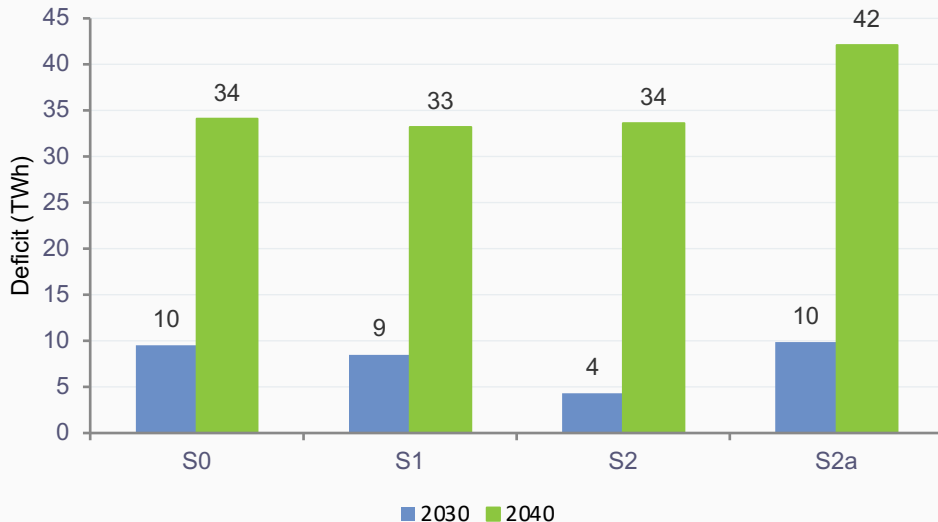


## Key Observations

- Double seasonal peak: winter (heating) + summer (cooling)
- January 2040: 13.6 TWh — worst month
- Spring surplus (March–May): hydro peak, low demand
- Surplus cannot shift to winter — no storage
- July peak: 12–13h midday, 6,840 MW deficit (2023)

# 5.1–5.2a. S1 Demand-Side & S2/S2a Gas-Led Scenarios

Annual Deficit at Milestone Years: S0 / S1 / S2 / S2a



## S1 (Demand-Side)

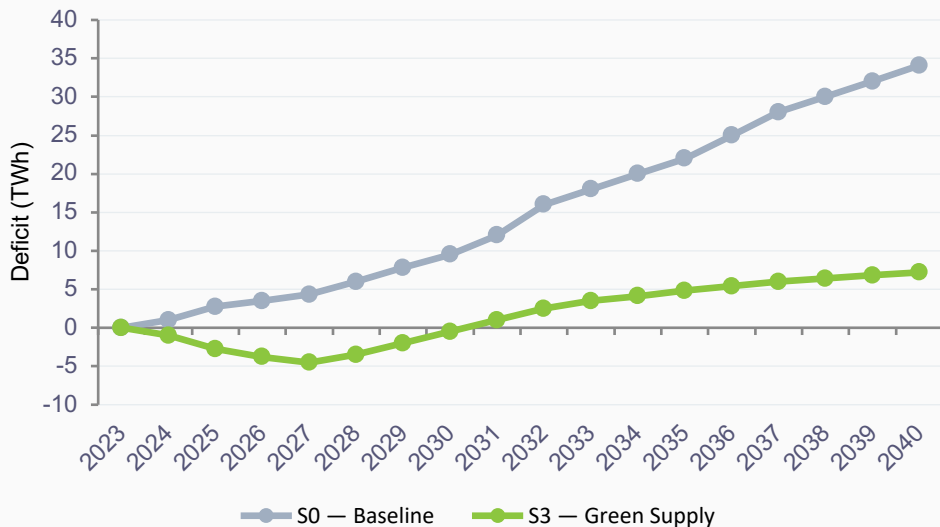
- M4 Rooftop PV: 353 → 8,500 GWh (2040)
- M5 EV demand: 119 → 7,668 GWh (2040)
- Seasonal benefit: summer only (PV)
- CO<sub>2</sub> avoided: 70 Mt cumulative

## S2 / S2a (Gas-Led)

- S2: step gain in 2025/2027, fades by 2040
- S2 2040: only 0.5 TWh better than S0
- S2a (+ EV): 42.1 TWh by 2040
- 2–3 bcm additional gas imports/year

# 5.3. S3 — Green Supply Pathway (M1 + M2, No Gas)

Annual Deficit: S0 vs S3 (2023–2040)



## S3 Key Results

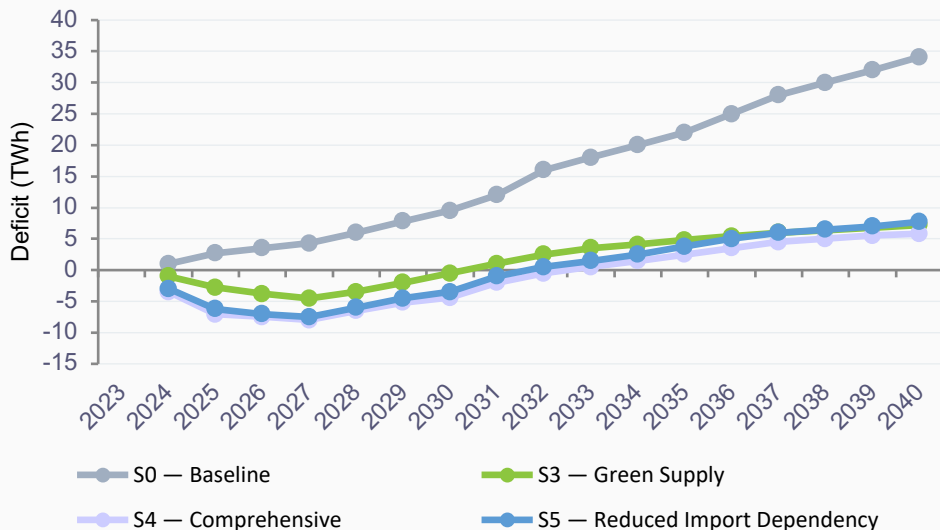
- M1 vRES: 5 → 25 TWh by 2040 (solar + wind)
- M2 imports: 500 → 1,900 GWh by 2040
- 2025–2031: annual surplus achieved
- January 2030: +1.82 TWh surplus vs –2.11 TWh S0
- Post-2031: deficit re-emerges (7.2 TWh by 2040)
- –79% vs S0 by 2040

## Key Limitation:

- Evening peak unresolved
- Re-emerging deficit after 2031 — demand grows faster
- Strongest CO<sub>2</sub> avoidance (130 Mt cumulative by 2039)

# 5.4–5.5. S4 & S5 — Comprehensive Pathways

Annual Deficit: S0 / S3 / S4 / S5 (2023–2040)



**-83%**

vs S0 by 2040

**5.82 TWh**

Deficit, 2040 (S4)

**10.1 TWh**

Import volume, 2040 (S4)

**504 MW**

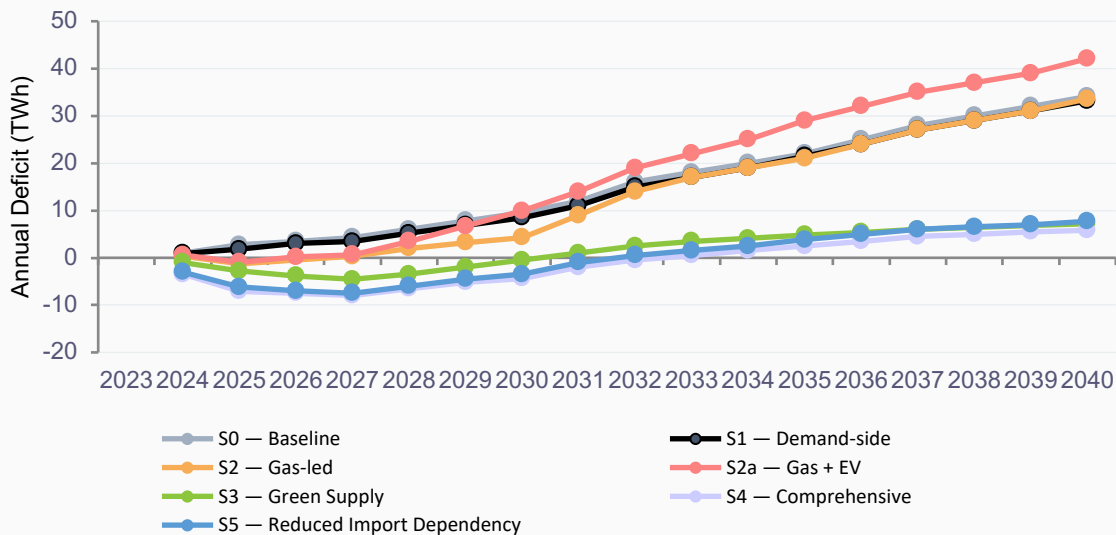
Max peak deficit (2030)

## S4 vs S5: Import contribution

- S4 vs S5 difference: 1.9 TWh by 2040
- Even S5 imports grow organically to 8.2 TWh
- Imports remain significant under all modelled scenarios

# 6.1. Cross-Scenario: Annual Deficit 2023–2040

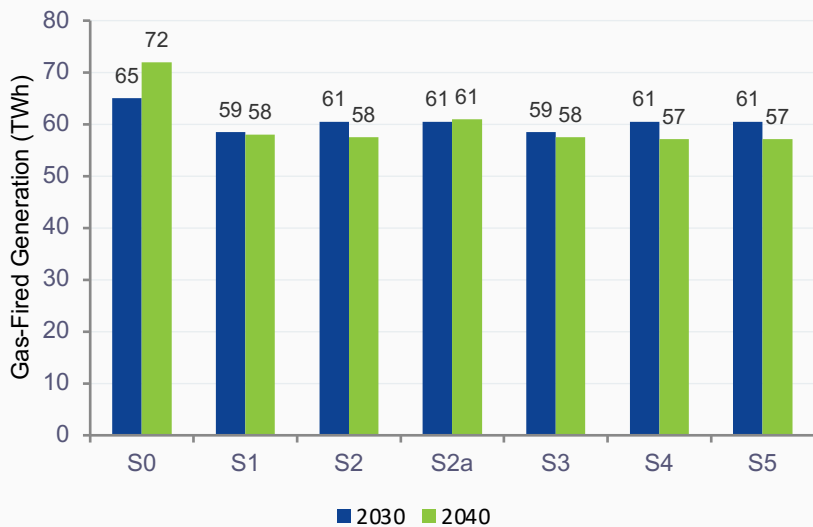
All 7 Scenarios: Annual Deficit 2023–2040 (negative = surplus)



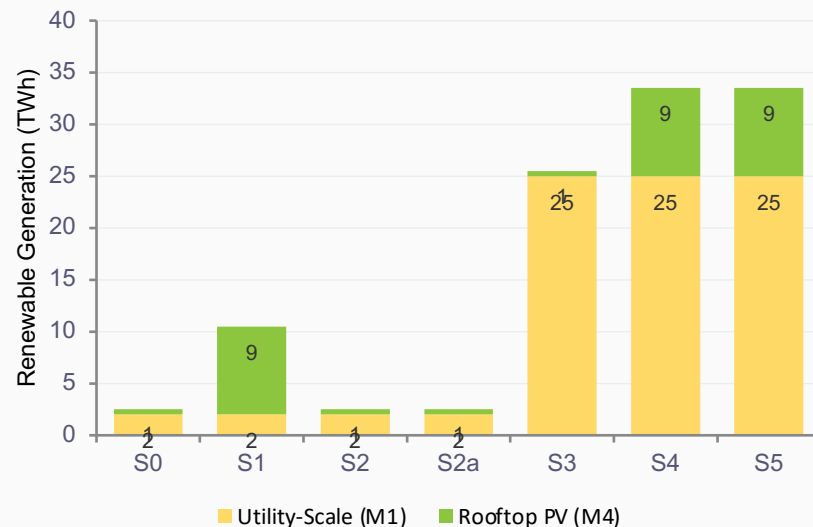
| 2040 Outcomes |           |       |
|---------------|-----------|-------|
|               | 2040, TWh | vs S0 |
| S0            | 34.1      | —     |
| S1            | 33.2      | -3%   |
| S2            | 33.6      | -1%   |
| S2a           | 42.1      | -24%↑ |
| S3            | 7.2       | -79%  |
| S4            | 5.8       | -83%  |
| S5            | 7.7       | -77%  |

# 6.2–6.3. Gas & Renewable Energy Across Scenarios

Natural Gas-Fired Generation by Scenario

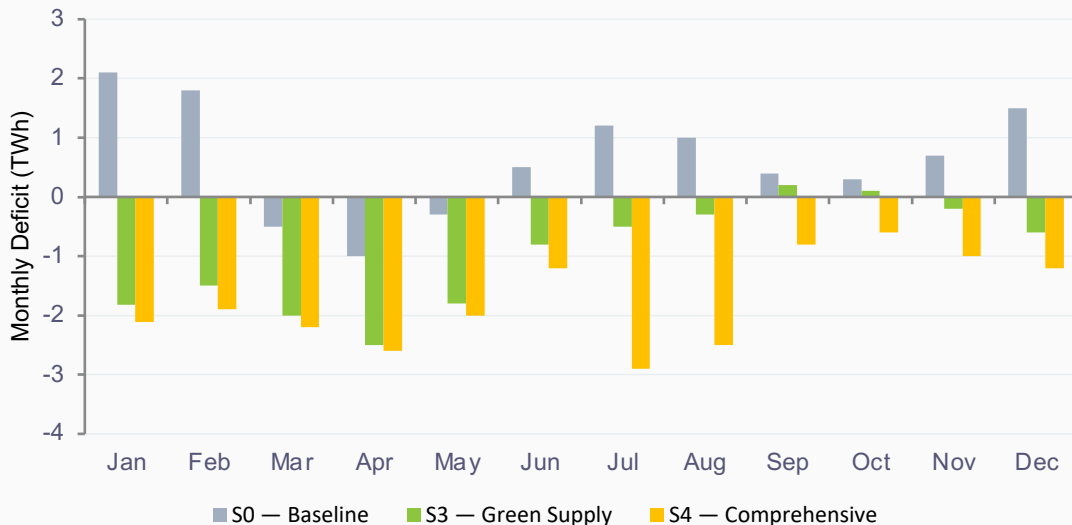


Renewable Energy Deployment by Scenario (2040)



# 6.4. Seasonal Constraints: Monthly Deficit (2030)

Monthly Deficit by Scenario, 2030 (negative = surplus)

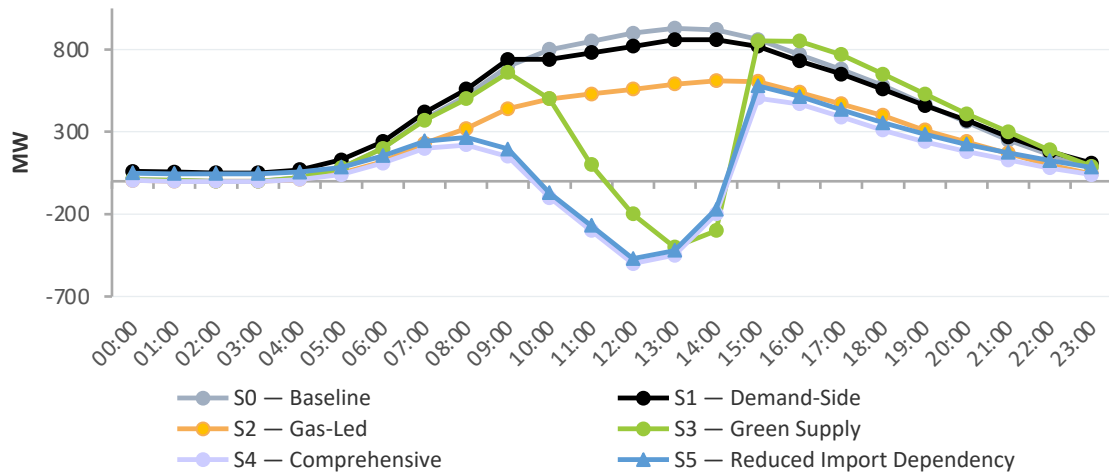


## Seasonal Findings

- S3 & S4: all 12 months in surplus in 2030
- Jan surplus (S3): +1.82 TWh vs -2.11 TWh S0
- Spring: deepest surplus (hydro + solar)
- Summer (Jul-Aug): all scenarios improve
- Winter: gas flexibility (S4) adds 1-2 TWh vs S3
- Post-2031: winter deficit returns even in S4

# 6.5. Cross-Scenario: Intraday Response, 2030

Hourly balance, peak day July 2030 — all scenarios (MW)  
(positive = deficit, negative = surplus)



| 2030 Outcomes |                   |       |
|---------------|-------------------|-------|
|               | Peak deficit (MW) | vs S0 |
| <b>S0</b>     | 929               | —     |
| <b>S1</b>     | 860               | -7%   |
| <b>S2</b>     | 606               | -35%  |
| <b>S3</b>     | 853               | -8%   |
| <b>S4</b>     | 504               | -46%  |
| <b>S5</b>     | 579               | -38%  |

# 7. Conclusions & Recommended Pathway

Without new policy action: electricity deficit reaches 34.1 TWh by 2040 (~25% of demand).

## Five Recommended Pathway:

