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The Great Sea Interconnector between Greece and Cyprus

Market and system impacts in 2035, the value of the Interconnector's transfer capacity and the effect of cheaper Cyprus gas



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CONTEXT

Why study the Great Sea Interconnector (GSI)?

01

An isolated island system

Cyprus has no electrical interconnection today.
Its annual consumption of 5.7 TWh and peak load of 1.3 GW is served by diesel-fired and oil-fired units.

Prices are high and volatile, and a large share of solar output is curtailed.

02

The Great Sea Interconnector

An HVDC link between the Greek system (via Crete) and Cyprus, rated at 1000 MW.

Assumed in operation in the study year 2035 (commissioning estimated for 2034).

03

Research questions

- How does coupling change prices, fuel use and RES curtailment?
- Who benefits: Greek or Cypriot consumers?
- How much transfer capacity (NTC) is actually needed?
- How robust are the results to cheaper gas in Cyprus?

METHODOLOGY

Hourly market simulation with the LTSx model

STEP 1

Day-ahead market

Day-Ahead-Market clearing for 8760 hours, Greece and Cyprus markets coupled through the GSI subject to the NTC

STEP 2

ISP and Real-time balancing

Scheduling phase and RTBEM dispatch in each system with FCR, aFRR and mFRR reserves; the GSI flow is not re-dispatched for balancing

STEP 3

Settlement and indicators

Prices, flows, congestion rent, fuel and CO_2, unit cycling, RES curtailment, uplift accounts and supply cost

SIMULATION SCENARIOS

Four NTC cases under two Cyprus gas prices

Scenario	Interconnector	NTC GR → CY	NTC CY → GR	Interpretation
No GSI (Base Case)	–	0 MW	0 MW	Cyprus operates in isolation
GSI-500	1000 MW cable	500 MW	500 MW	Conservative security limit
GSI-750	1000 MW cable	750 MW	750 MW	Intermediate limit
GSI-1000	1000 MW cable	1000 MW	1000 MW	Full cable rating

What changes

(a) The NTC in each direction
(b) The gas price of the Cypriot units (**−10 €/MWh**) (Sensitivity scenarios)

What stays the same

Demand, RES and storage, thermal fleet, Greek gas prices, and CO_2 price.

Greece is mainly renewable; Cyprus only half-way

	Greece	Cyprus
Load scenario	Base (adjusted ADMIE scenario)	Intermediate
Annual demand	62.99 TWh	5.93 TWh
Peak load	13,360 MW	1,685 MW
RES capacity (end of 2035)	29,553 MW	1,650 MW
• PV	20,125 MW	1,437 MW
• Wind	8,657 MW (incl. 750 MW offshore)	170 MW
• Small hydro, biomass, CHP	771 MW	43 MW (Biomass)
Potential RES output (excl. large hydro) / Share of demand	53.24 TWh / 84.5%	2.83 TWh / 47.8%

Storage, conventional units and interconnections

	Greece	Cyprus
Battery storage	8,800 MW / 2-h: 40%, 4-h: 60% / RTE: 86%	415 MW / 2-h: 166 MW, 4-h: 249 MW / RTE: 86%
Pumped storage	1,955 MW / 7 plants (Existing & New)	–
Large hydro	3,443 MW	–
Gas-fired units	7,468 MW / Lignite fully phased out	1,220 MW / Vasilikos CC and ST units, new CCGTs *
Oil-fired units	–	330 MW / Gasoil GTs (Moni, Dhekelia), HFO ICE units
Must-run units	≈ 800 MW / 2 large CCGTs @ technical minimum + Aluminium CHP	180 MW (inertia requirement)
Interconnections	New: Albania +200 MW, Turkey +600 MW, Italy +1,000 MW	GSI only (in the GSI scenarios)

* *Existing Vasilikos thermal units (Steam and CCGTs) will be transformed to gas-fired units before 2035.*

New CCGTs: PEC (≈260 MW) and EAC (≈ 160 MW) are expected to be commercially available in 2035.

Fuel and carbon prices: Reference and sensitivity scenarios

Natural gas

27.97 €/MWh

HHV, TTF-based, excl. transmission charges / Reference, both systems

CO_2 emission allowance

121.9 €/t

EU ETS price applied in both systems

Natural gas, Cyprus (sensitivity scenarios)

17.97 €/MWh

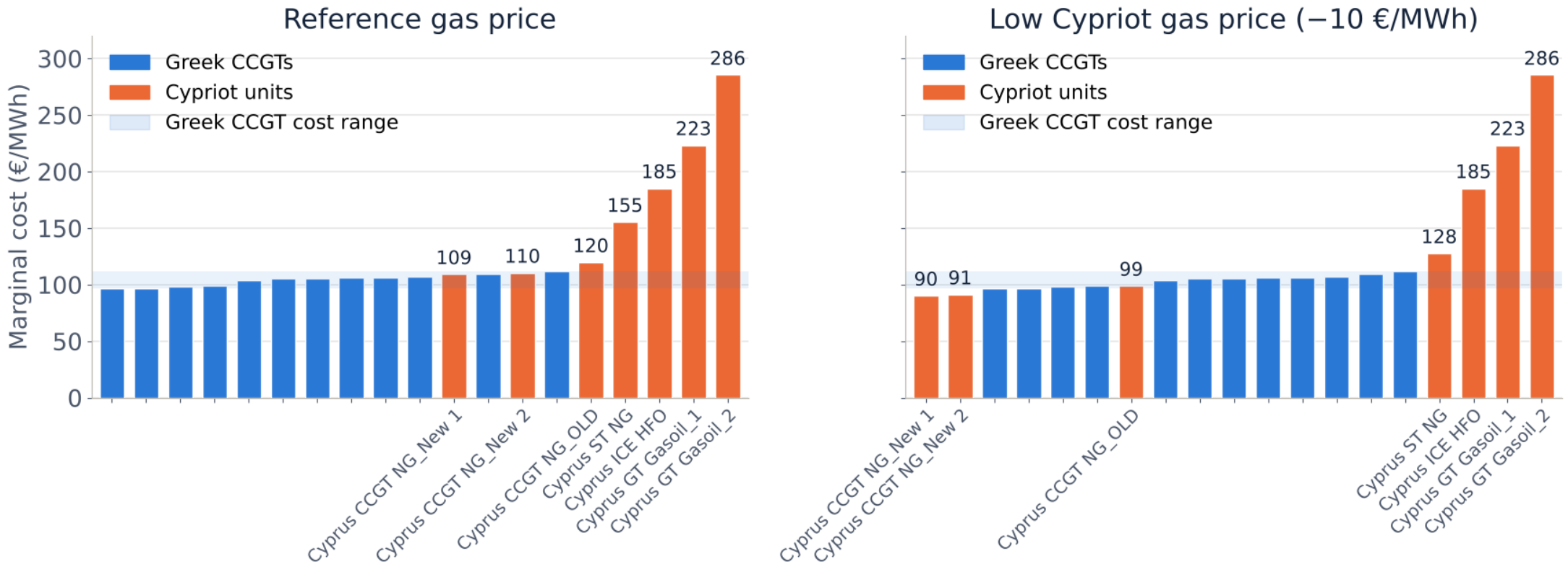
Heavy fuel oil (Cyprus)

429 €/t

Gasoil (Cyprus)

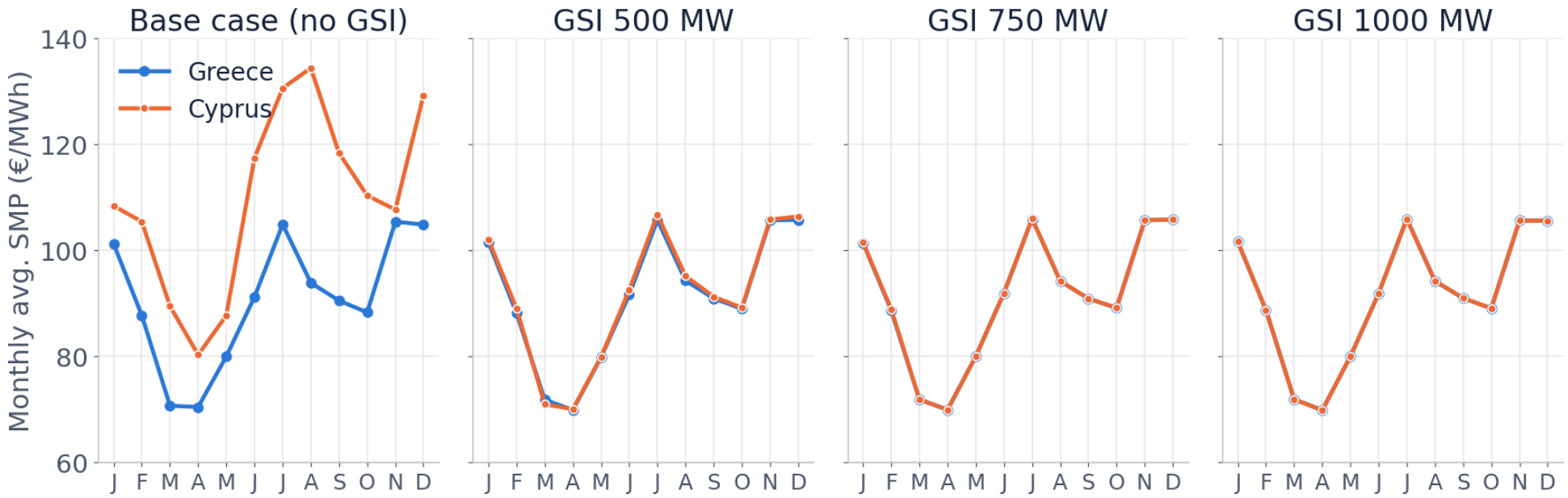
613 €/t

Cheaper gas moves Cypriot CCGTs ahead of the Greek units



With 10 €/MWh cheaper gas, the new Cypriot CCGTs become the cheapest thermal units and the older ones fall within the Greek CCGT range.

Cypriot DAM prices converge to the Greek level



112.0 → 90.5

Cyprus load-weighted price, €/MWh (GSI-500)

−19%

≈ −21.5 €/MWh for Cypriot consumers

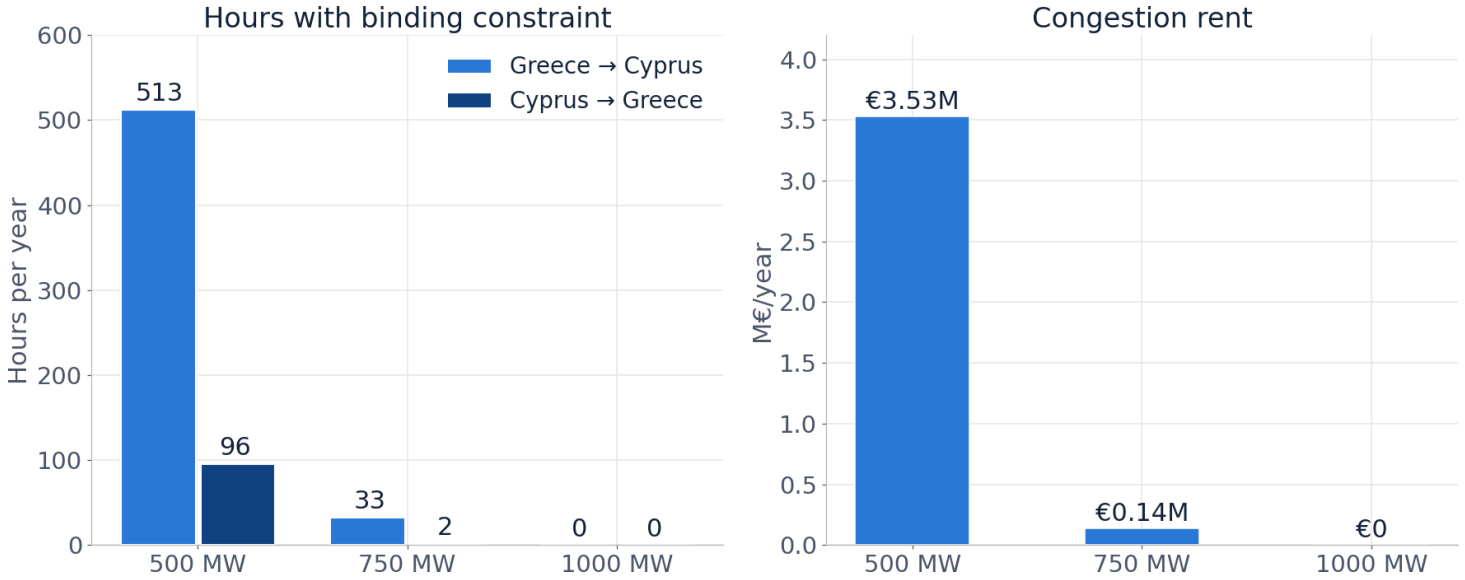
+0.4 to +0.5

Change in Greek price, €/MWh (90.6 → 91.0)

8,151 h

Full price convergence at GSI-500 (8,725 at GSI-750 / 8,760 h at GSI-1000)

The transfer limit is binding in few hours, even at 500 MW



609 / 35 / 0 hours

Binding hours at 500 / 750 / 1000 MW (7% of the year at most)

513 of 609 h

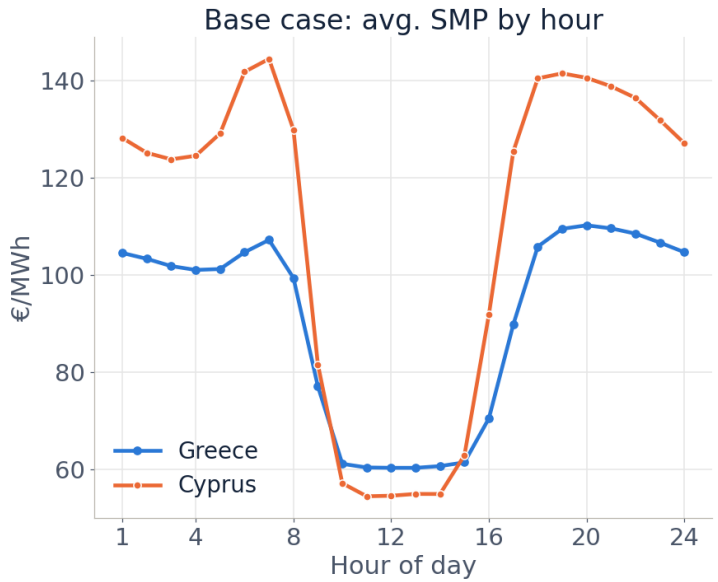
Direction Greece → Cyprus at 500 MW

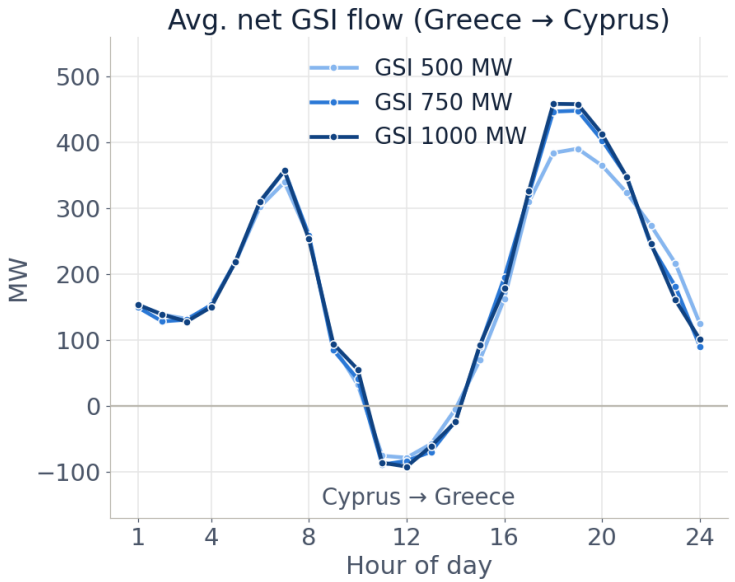
3.53 M€

Congestion rent at 500 MW (0.14 M€ at 750 MW)

Binding Hour = Hour with DAM price difference between the two zones, i.e. with congestion rent.

Cyprus imports about a quarter of its demand





1.54 – 1.60 TWh

Annual net flow Greece → Cyprus

26 – 27%

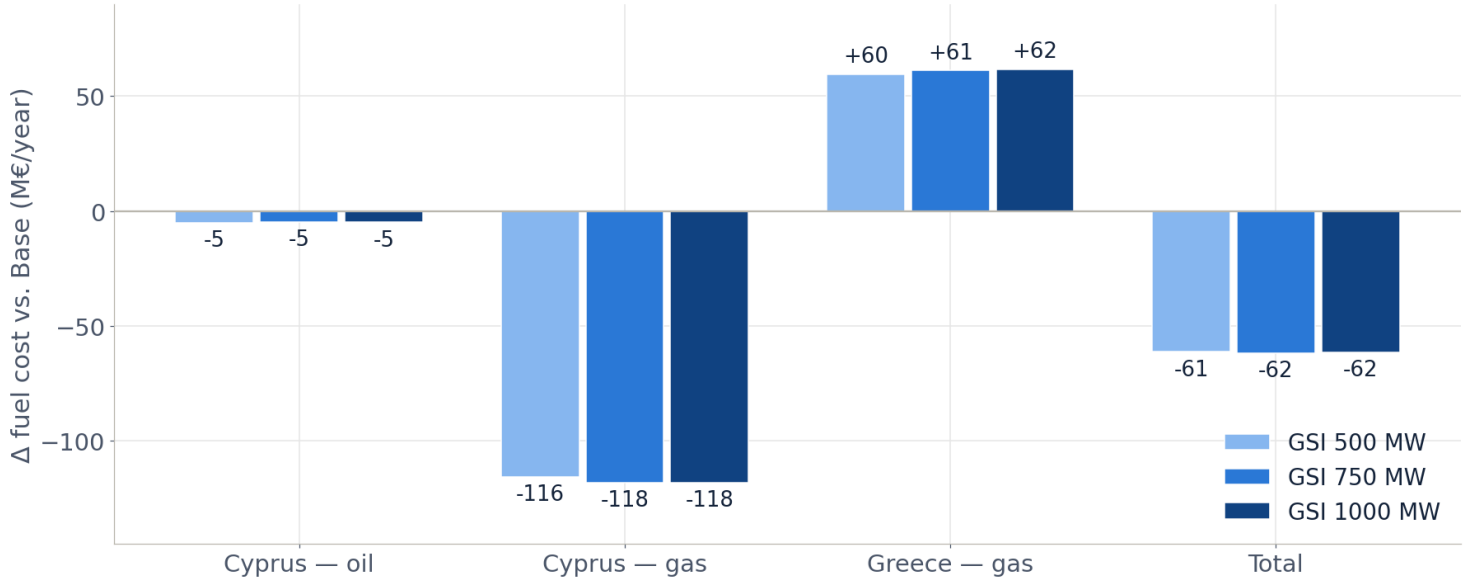
Share of Cypriot demand covered by net imports

≈ 390 – 460 MW

Average evening import peak (500 → 1,000 MW)

- ✓ Imports to Cyprus in the evening and night
- ✓ Around midday the flow reverses and Cyprus exports part of its solar surplus.

Thermal generation moves from Cyprus to Greece



−50% gas / −42% oil

Cypriot fuel use / Fuel bill: 247 → 124–126 M€

+5.3 to +5.5%

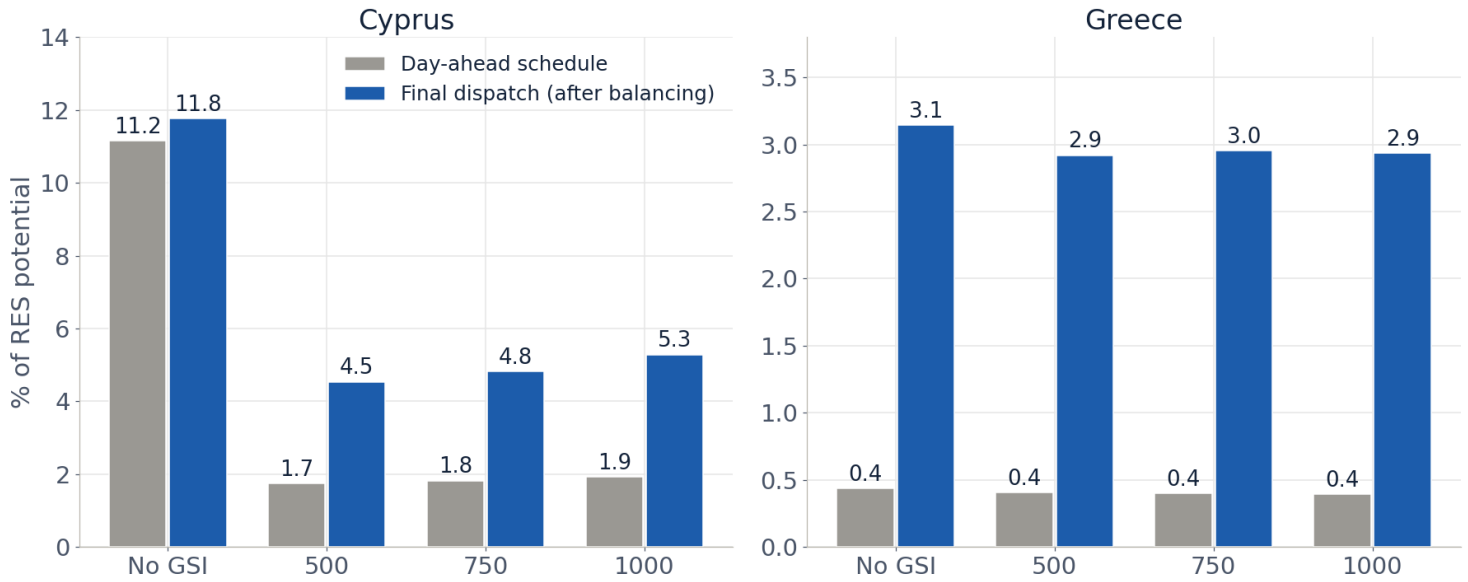
Greek gas use / Fuel bill: +60 to +62 M€

−4.5% / −3.5%

Total fuel cost (≈ −61 M€) / CO_2 (≈ −0.29 Mt)

- ✓ Efficient Greek CCGTs and RES replace Cypriot steam, gas-turbine and ICE units.
- ✓ The result hardly depends on the NTC.

RES curtailment in Cyprus falls by more than half



11.8% → 4.5%

Cyprus, final curtailment at 500 MW
(4.8% at 750 MW / 5.3% at 1000 MW)

17 → 79 – 95 GWh

Cyprus, RES down-regulated in real time

3.1% → 2.9%

Greece, final curtailment

- ✓ Day-ahead RES curtailment in Cyprus drops to below 2%
- ✓ With fewer Cypriot thermal units online in real-time, the downward balancing needs are increasingly met by curtailing RES.

Consumers save 123–138 M€ a year, almost all in Cyprus

Indicator	No GSI	GSI-500	GSI-750	GSI-1000
Greece, supply cost (incl. UAs) (€/MWh)	**102.22**	101.99	102.28	102.14
Cyprus, supply cost (incl. UAs) (€/MWh)	**120.49**	99.14	98.64	99.17
Total consumer cost (incl. UAs) (M€/yr)	**6,994.7**	6,856.6	6,871.9	6,866.4
Change vs No GSI / Greece (M€/yr)	–	**−14.3**	**+3.9**	**−4.7**
Change vs No GSI / Cyprus (M€/yr)	–	**−123.7**	**−126.6**	**−123.6**
Change vs No GSI / Total (M€/yr)	–	**−138.1**	**−122.7**	**−128.2**

−21.3 €/MWh (−18%)

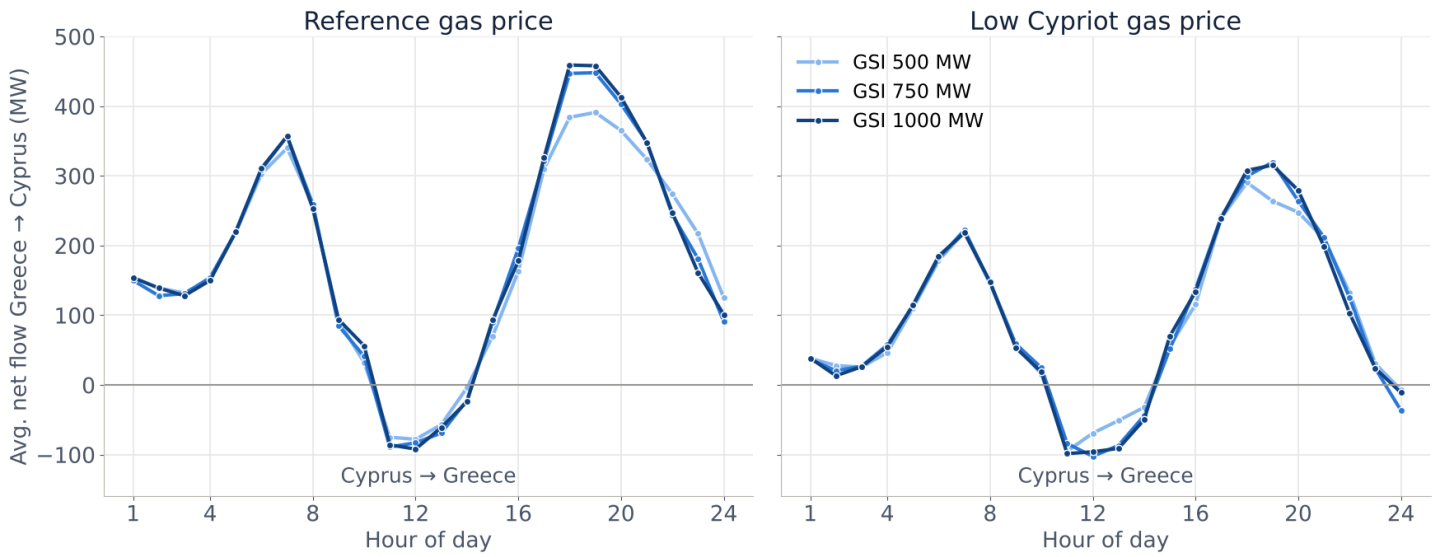
Cypriot supply cost at 500 MW

−0.2% to +0.1%

Greek supply cost: practically unchanged

SENSITIVITY / LOW CYPRIOT GAS PRICE

With cheaper gas in Cyprus the GSI is used less, and in both directions



−21.5 → −5.3 €/MWh

Effect of the GSI on the Cypriot DAM retailers' cost (for GSI-500 MW)

≈ 1.6 → 0.8 TWh

Annual net flow Greece → Cyprus (≈ 13.5% of Cypriot demand)

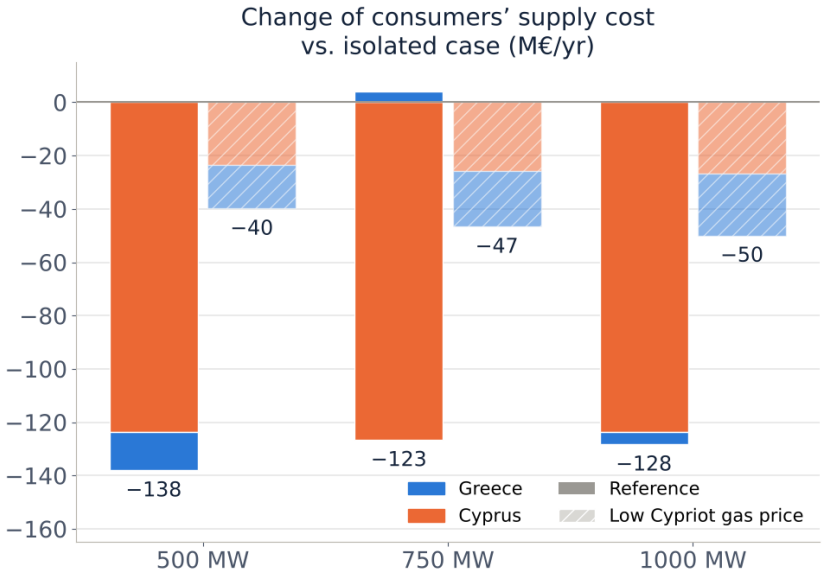
+40%

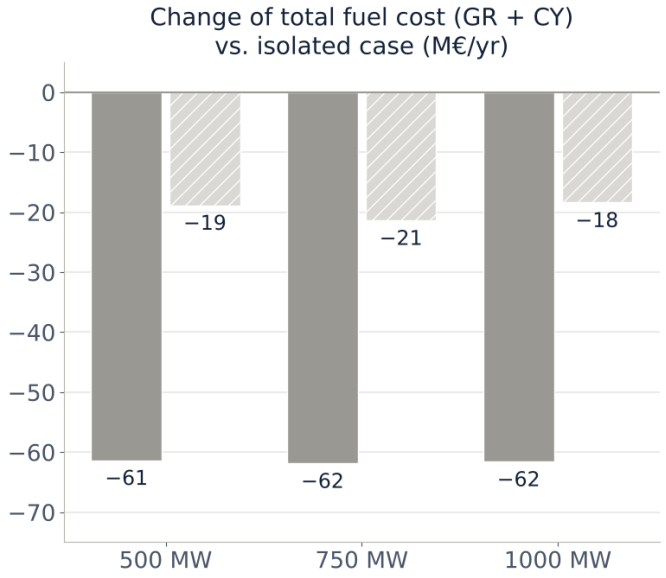
Flows Cyprus → Greece (≈ 560–590 GWh/yr)

- ✓ Night-time imports almost disappear and the evening peak imports falls
- ✓ At 500 MW binding hours drop from 609 to 367, 40% of them towards Greece.

SENSITIVITY / LOW CYPRIOT GAS PRICE

Benefits shrink by about two-thirds but remain positive





40 – 50 M€/yr

Consumer savings (Reference: 123 – 138 M€/yr)
Greece: 16 – 23 M€/yr, Cyprus: 23 – 27 M€/yr

18 – 21 M€/yr

Fuel-cost savings (Reference: 61 – 62 M€/yr)
CO_2 emissions: −224 to −243 kt/yr

3.5 – 3.8%

RES curtailment in Cyprus (Reference: 4.5 – 5.3%)

The final Cypriot supply cost with the GSI is ≈ 98–99 €/MWh in both sets: for Cypriot consumers, domestic gas and the GSI are largely substitutes.

THE VALUE OF TRANSFER CAPACITY

500 MW captures most of the benefit in both cases

- ✓ Reference scenario: Higher NTC adds no savings.
- ✓ Low Cypriot gas price: Higher NTC adds savings of 7–10 M€/yr and slightly lowers RES curtailment.

Indicator	No GSI	500 MW	750 MW	1000 MW
Reference gas price				
Greece supply cost (incl. UAs) (€/MWh)	102.2	102.0	102.3	102.1
Cyprus supply cost (incl. UAs) (€/MWh)	120.5	99.1	98.6	99.2
Total Consumer savings (GR & CY) (M€/yr)*	-	**138.1**	**122.7**	**128.2**
RES curtailment, Cyprus	11.8%	4.5%	4.8%	5.3%
Low Cypriot gas price				
Greece supply cost (incl. UAs) (€/MWh)	102.2	102.0	101.9	101.8
Cyprus supply cost (incl. UAs) (€/MWh)	102.9	98.8	98.4	98.3
Total Consumer savings (GR & CY) (M€/yr)*	-	**39.9**	**46.6**	**50.0**
RES curtailment, Cyprus	11.8%	3.8%	3.7%	3.5%

** Excluding congestion rent*

CONCLUSIONS

Six findings for 2035

1. **The GSI ends Cyprus's price isolation:** The Cypriot DAM price falls by about 21.5 €/MWh (−19%) to the Greek level, which rises by only 0.4–0.5 €/MWh.

2. **Cheaper and cleaner operation:** Total fuel cost −4.5% (≈ −61 M€/yr) and CO_2 −3.5% (≈ −0.29 Mt), as Cypriot thermal output halves.

3. **Better use of renewables:** RES curtailment in Cyprus falls from 11.8% to about 5%, and Cypriot thermal units start and run far less.

4. **Consumers save 123–138 M€/yr,** almost entirely in Cyprus (−18% supply cost); Greek consumers are practically unaffected.

5. **An NTC of 500 MW captures most of the benefit:** Higher limits add little benefit (nothing in the reference set, 7–10 M€/yr with cheaper Cypriot gas). Balancing remains separate in each system.

6. **Robust but price-dependent:** With cheaper domestic gas in Cyprus all benefits remain, but consumer savings due to GSI fall to 40–50 M€/yr and the GSI is used in both directions.

LIMITATIONS AND FUTURE WORK

What the results do not yet capture

Limitations

- One study year with a single set of weather and demand conditions
- Fuel-price sensitivity limited to the Cypriot gas price
- GSI flows fixed after the day-ahead market: no cross-border balancing
- Investment cost and its allocation are outside the scope

Future work

- Cross-border balancing over the GSI and access to European balancing platforms
- Several weather years and wider fuel / CO_2 price scenarios
- Higher Cypriot demand and RES scenarios
- Full cost-benefit analysis, including investment cost and cost allocation

Thank you

Questions & Discussion



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