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ECONOMIC CONSULTING

Fostering International Cooperation in Energy Market Design

Case Study - GCCIA

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Insight in Economics™

It's Christmas for importers of German power…
What can go wrong if the energy market is not set up properly?

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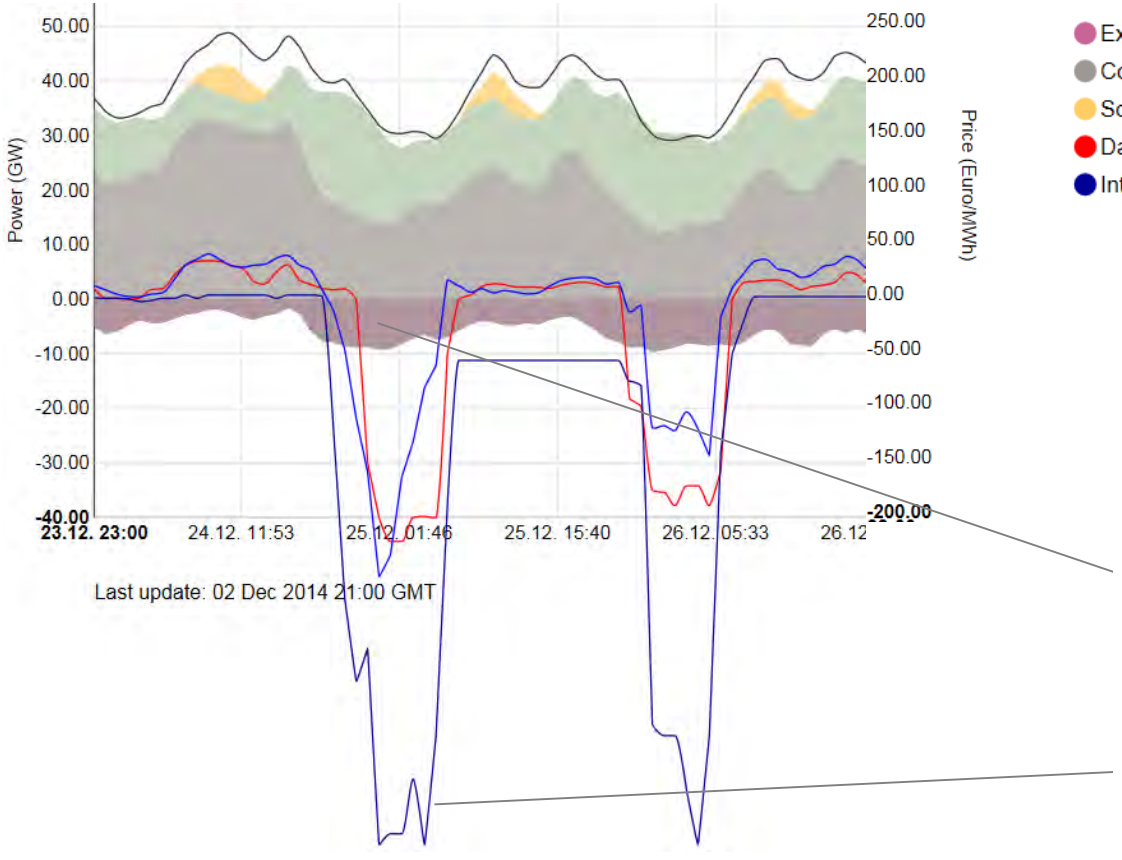

Germany exported about 8GW of power…

… and paid up to €400 per MWh of exported electricity

It's not enough to build an infrastructure, there should be appropriate market mechanisms in place to make it work effectively

Solar revolution is happening in the GCC, due to the drastic reduction in solar PV and CSP prices combined with ambitious renewable expansion plans

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Solar PV and CSP prices have been decreasing rapidly

Bloomberg Markets

3 Oct. 2017: "Saudi Arabia Gets Cheapest Bids for Solar Power in Auction"

"*Abu Dhabi's Masdar and Electricite de France SA bid to supply power from a 300-megawatt **photovoltaic plant** for as little as 6.69736 halalas a kilowatt hour, **or 1.79 cents**, according to a webcast of the bid-opening ceremony on Tuesday in Riyadh. If awarded, that would beat the previous record for a solar project in Abu Dhabi for **2.42 cents** a kilowatt-hour*".

SolarPACES

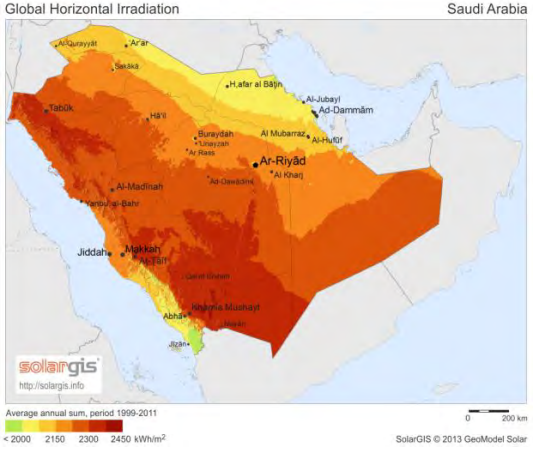
29 Oct. 2017: "Solar Thermal Power Prices have Dropped an Astonishing 50% in Six Months"

"Here is the price trajectory for CSP + thermal storage between May and October, 2017:

- *In May, **Dubai's DEWA** received a solar bid at a new low of just **9.4 cents/kWh**.*
- *In August, [in **Dubai**], **ACWA Power** won a contract at a record breaking new low price – at just **7.3 cents/kWh***
- *In September, [in **Australia**]]**SolarReserve** won a solar contract at yet another record low price of **6.1 cents/kWh***
- *In October, **SolarReserve** bid in Chilean auctions at a new world record low price of under **5 cents/kWh**".*

The Arabian Peninsula has high solar potential (and ambitious plans)

Solar irradiance in the GCC



Source: Solargis.com

Source: Bloomberg Markets, SolarPACES

Challenges with solar integration: security of supply

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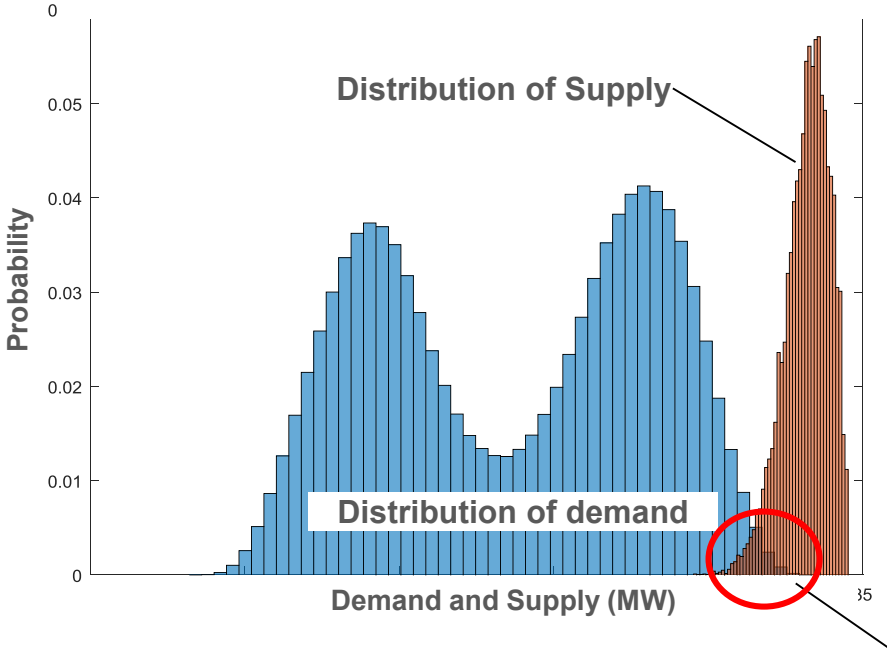
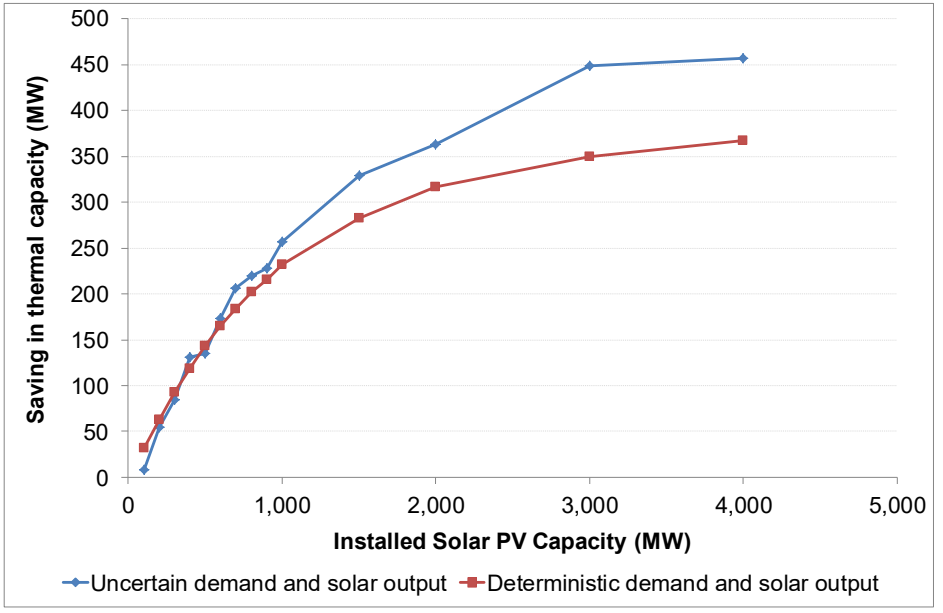
Calculation of LOLE loss of load expectation: Illustrative supply and demand distributions



Source : NERA's illustrative analysis

The Contribution of Solar PV Capacity to Security of Supply (illustrative calculations)



The security of supply contribution of additional solar PV capacity diminishes as more solar PV is installed

More challenges… With high PV penetration, must run constraints may prevent full utilisation of PV capacity

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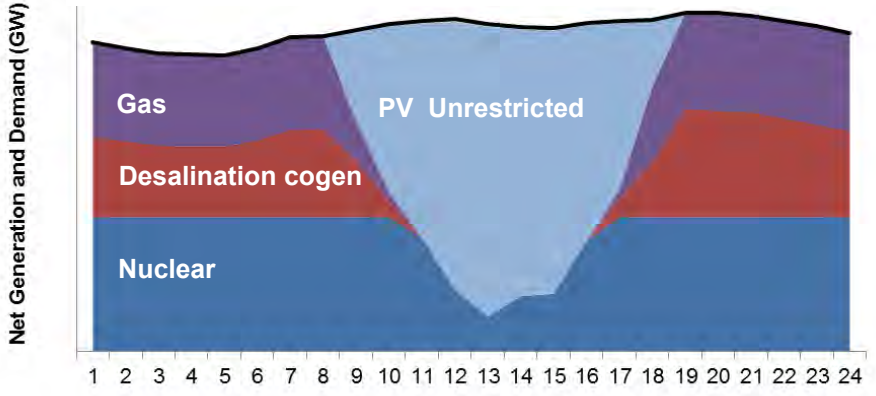
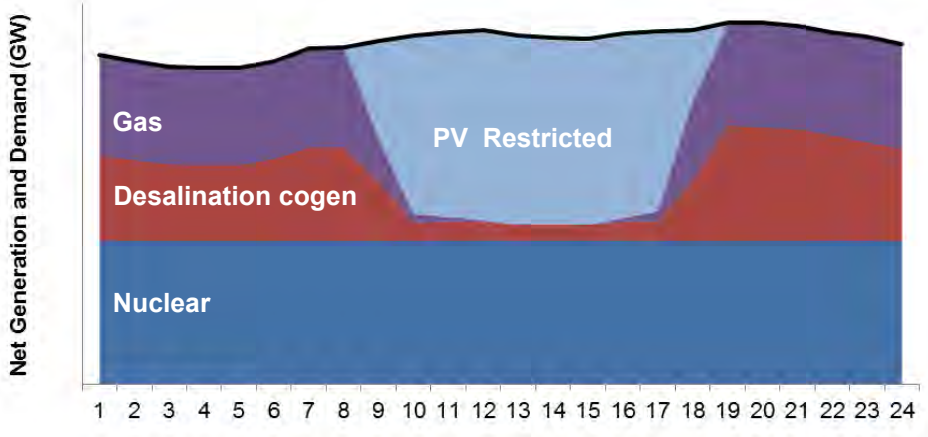
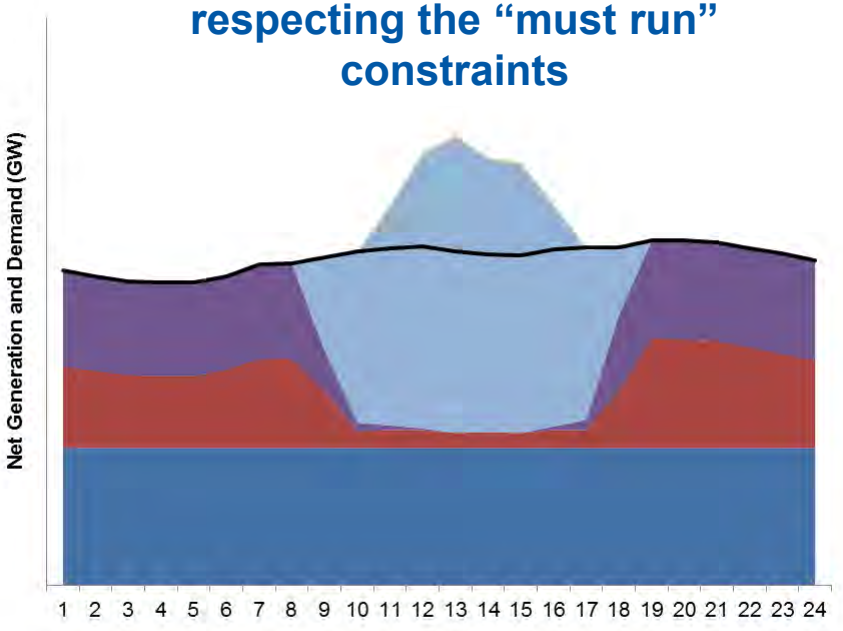
Without must run constraints, PV generation is unrestricted



In practice, must run constraints may restrict the output of solar PV plants



The Interconnector can help find an outlet for excess solar power while respecting the "must run" constraints



Source: NERA analysis using illustrative data

The GCC Interconnector primarily provides emergency support to Member States (since 2009)

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Member States could benefit from increased use of the Interconnector

Potential Benefits:

- Savings from **lower installed capacity** requirements (to meet the same security of supply standard)
- Savings from **sharing spinning reserve** across the interconnected GCC region
- Savings from **energy trading** (ie. efficient dispatch across the GCC)

Challenges in realising the full potential benefits of the IC:

- Some Member States **do not account for the IC in planning generation capacity**
- **maintain more spinning reserve** than required by the GCCIA
- **only exchange energy in emergencies**, and hardly ever trade to save fuel

The Interconnector connects the electricity networks of the six GCC Member States

Less than 0.3% of demand was traded in 2016 as a pilot project

Sources: Challenges in Realising the Potential of the GCCIA Interconnector: Vakhtang Kvekvetsia, Mohamed Al-Shaikh, Richard Druce; GCCIA annual report 2016

Member States cooperate in sharing reserve capacity and collectively set Installed Capacity Obligations for 5 years ahead

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1 Aggregate Demand & Calculate Coincidental Peak

- Construct aggregated hourly demand forecast of the six member states including only the zones directly connected to the interconnector
- Forecast installed capacity at the beginning of the year

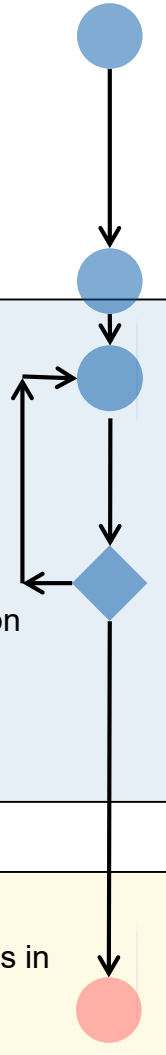
2 Capacity Expansion using ICO Procedure

Monte Carlo Simulation of Outages AURORAxmp

- Run Monte Carlo Simulations to calculate LOLE for all target years (Treating GCC as a single region with no interconnection constraint)

Check for Target LOLE

- If **LOLE < Target** go to next step
- If **LOLE > Target** then
  - **Add capacity** from the member states capacity expansion plans
  - Add generic new entrant capacity if above is exhausted
  - Repeat Monte Carlo Simulation & Calculation of LOLE



3 Member State ICO Determination & Feasibility Checking

Calculate Country-Specific ICO

- Record ICO for each year, calculate the corresponding RM and allocate across the Member States in proportion of contributions to aggregate forecast coincident peak load

The idea is to create an obligation and let the Member States trade capacity to meet the obligation

However, most Member States tend to overbuild compared to installed capacity obligations

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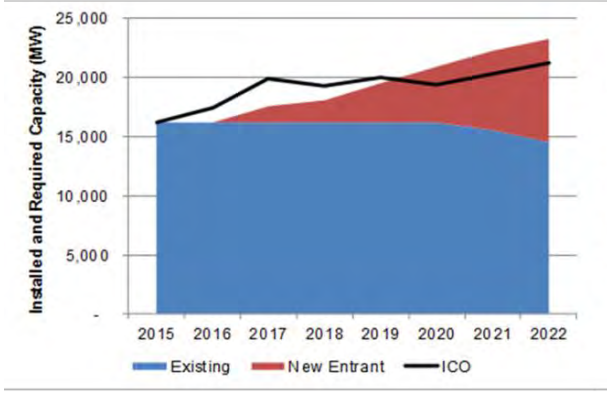
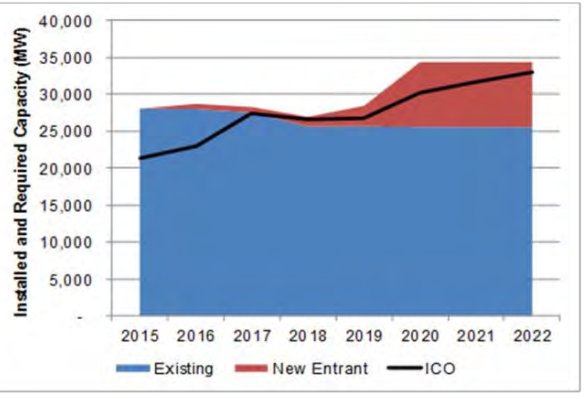
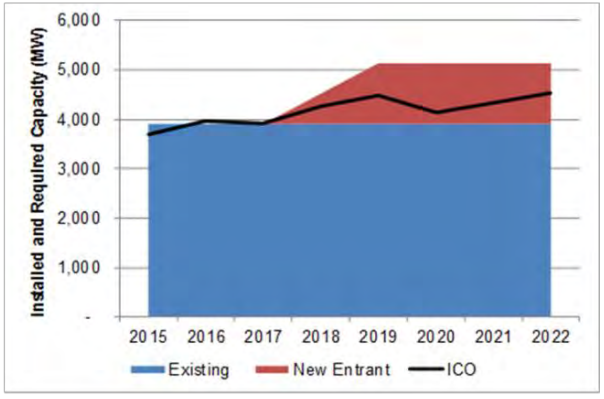
Kuwait



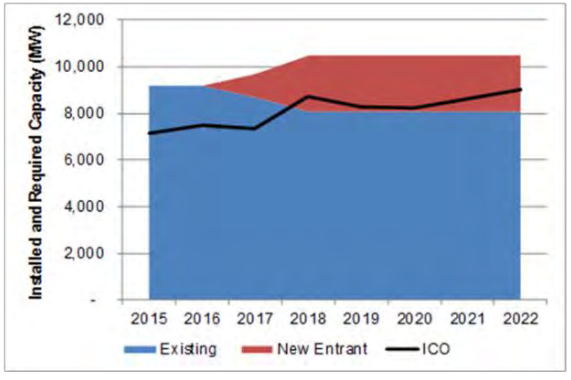
KSA (Eastern Zone)



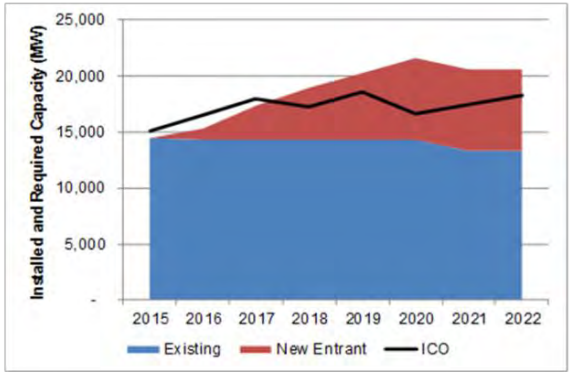
Bahrain



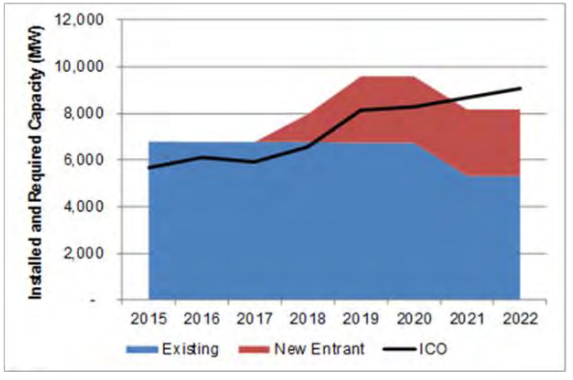
Qatar



UAE (Abu Dhabi)



Oman



Source: Challenges in Realising the Potential of the GCCIA Interconnector: Vakhtang Kvekvetsia, Mohamed Al-Shaikh, Richard Druce, CIGRE Conference Paper

Reasons for overbuilding

Lumpiness of investment projects	• Can be addressed by trading capacity from other Member States
Interconnection constraints	• ICO Determination Procedure assumes no interconnection constraints • Sensitivities in the ICO study show that transmission constraints are an important factor for security of supply
Accounting for the IC in MSs' capacity planning	• Member States may not take account of the interconnector for internal capacity expansion planning due to limited understanding of its capacity value
Demand uncertainty	• ICO Determination Procedure uses 50th percentile of demand. In reality, demand uncertainty needs to be considered in capacity expansion planning
Lack of trust	• Some Member States require additional guarantees to trust that other Member States will provide power in system stress events

There are ways to facilitate Member States' use of the Interconnector

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Several factors make the dependability of IC capacity uncertain:

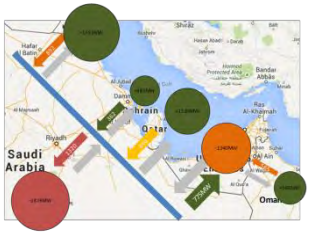
- Interconnector constraints;
- Regulatory restrictions (18 hours limit on the interconnection usage for emergency);
- Availability of generation in the neighbouring Member States;

In the absence of market arrangements, we can quantify the reliable interconnector capacity implied by the existing intergovernmental agreement:

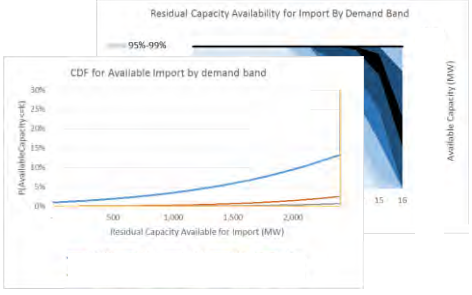
- **Step 1:** Simulate generation outages and demand across the region
- **Step 2:** From the point of view of each Member State, derive distributions of available capacity behind the interconnector, taking into account ALL interconnector constraints.
- **Step 3:** Use the distributions from Step 2 in the Member States's own capacity planning model to reflect the contribution of the interconnector.

Illustrative example of capacity requirements under different scenarios to meet 5 hours of LOLE

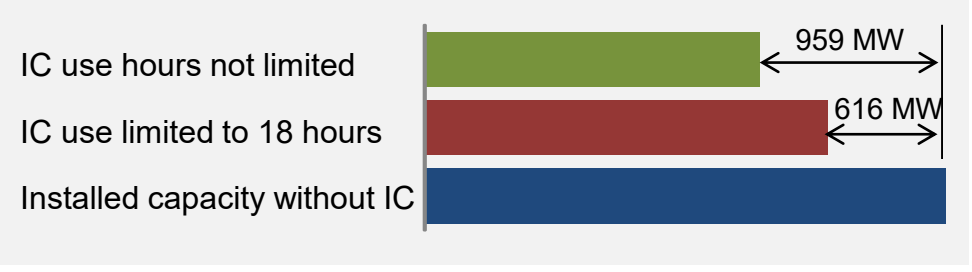
Step 1



Step 2



Step 3



Source: ***NERA Analysis***

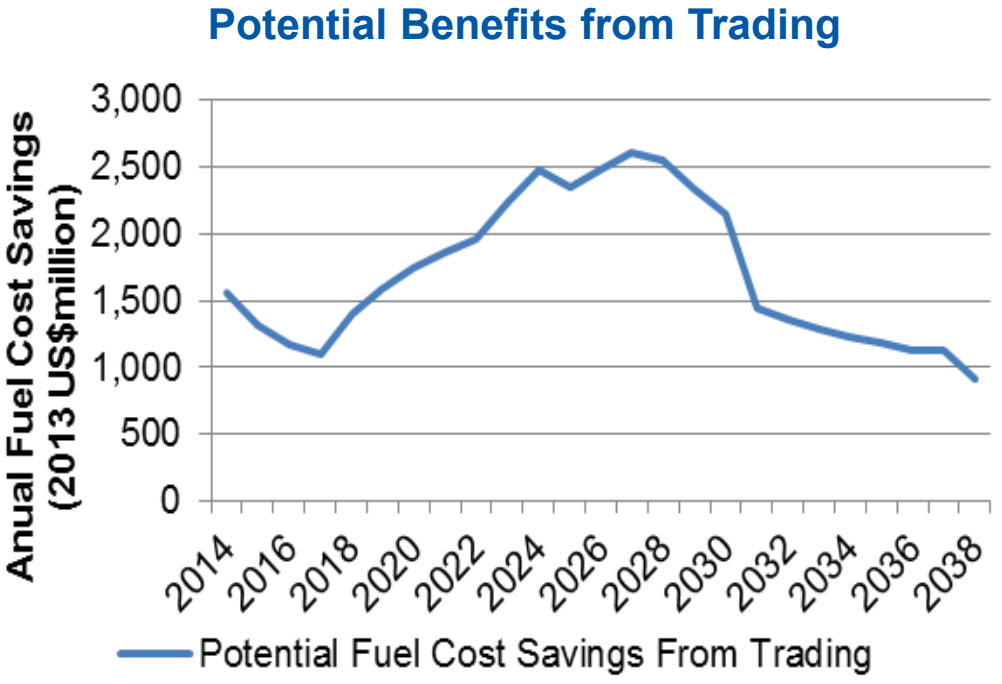
Significant additional rewards are left on the table by not trading over the interconnector

Base case

- No energy trading

Counterfactual

- Free power exchange, least cost dispatch across the interconnected GCC region



Note: Fuel costs are based on international prices

Challenges with fully realising the estimated benefits:

- In reality, the fuel prices that the generators face in some Member States are significantly lower than the international comparators. Differentiated subsidy regimes are not naturally conducive to trade
- Work In progress: pilot trades are taking place using the new trading platform. Fundamentally, even with the subsidies one can find a set of prices at which it is still beneficial to exchange energy on a bilateral basis and save on fuel costs.

Source: Challenges in Realising the Potential of the GCCIA Interconnector: Vakhtang Kvekvetsia, Mohamed Al-Shaikh, Richard Druce

The future is bright…

DESERTEC FOUNDATION

"Within 6 hours deserts receive more energy from the sun than humankind consumes within a year"

arab news

"through its planned grid in Turkey, the Kingdom [KSA] would also have the opportunity to supply power to European countries in the future" (12 Oct 2017)

One day, the desert sun may light up Christmas trees in Europe

Source: Desertec.org; arabnews.com; wikimedia.org

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