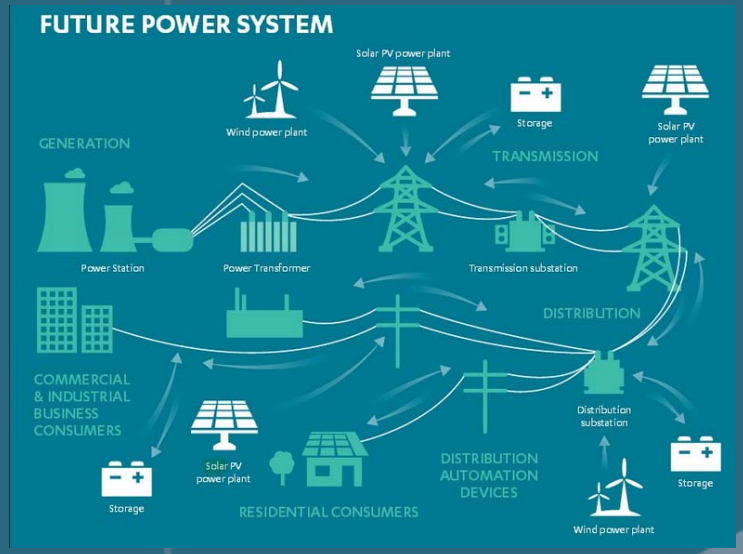
2nd AIEE Energy Symposium
Rome, 3/11/2017

Increasing interconnections in a small, open economy

A quantitative evaluation of its effects



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Sectoral Direction

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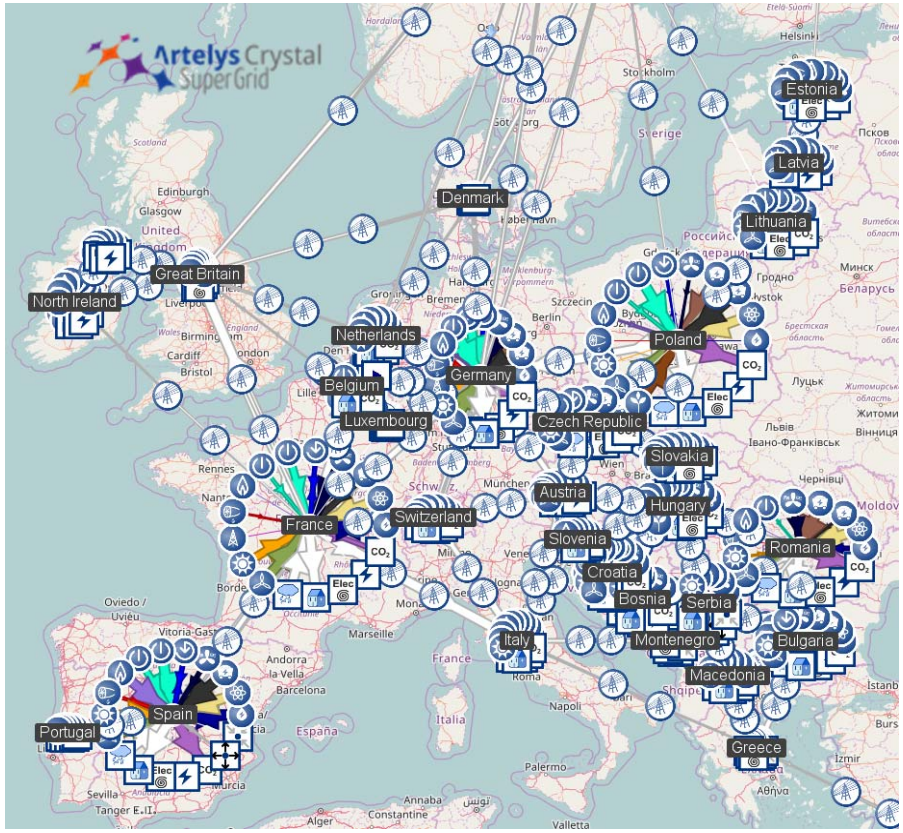
Methodology: Crystal Super Grid

- Unit commitment, optimal dispatch
- Rolling horizon
- Horizon 2027
- Hourly load profile
- Especially suited to investigate interconnected future power systems with large penetration of vRES
- CO_2 emissions



Source: Crystal Super Grid.

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Hypotheses: Installed capacity

MW	CCGT	OCGT	Solar	Wind	Cogen	Biomass	Nuclear
2027			4988	5854	2938	1281	0

Source: Eurostat (2017), Elia (2016).

- Thermal flexible park as of 2017
- Database from Elia

  SR Winter 2017-2018

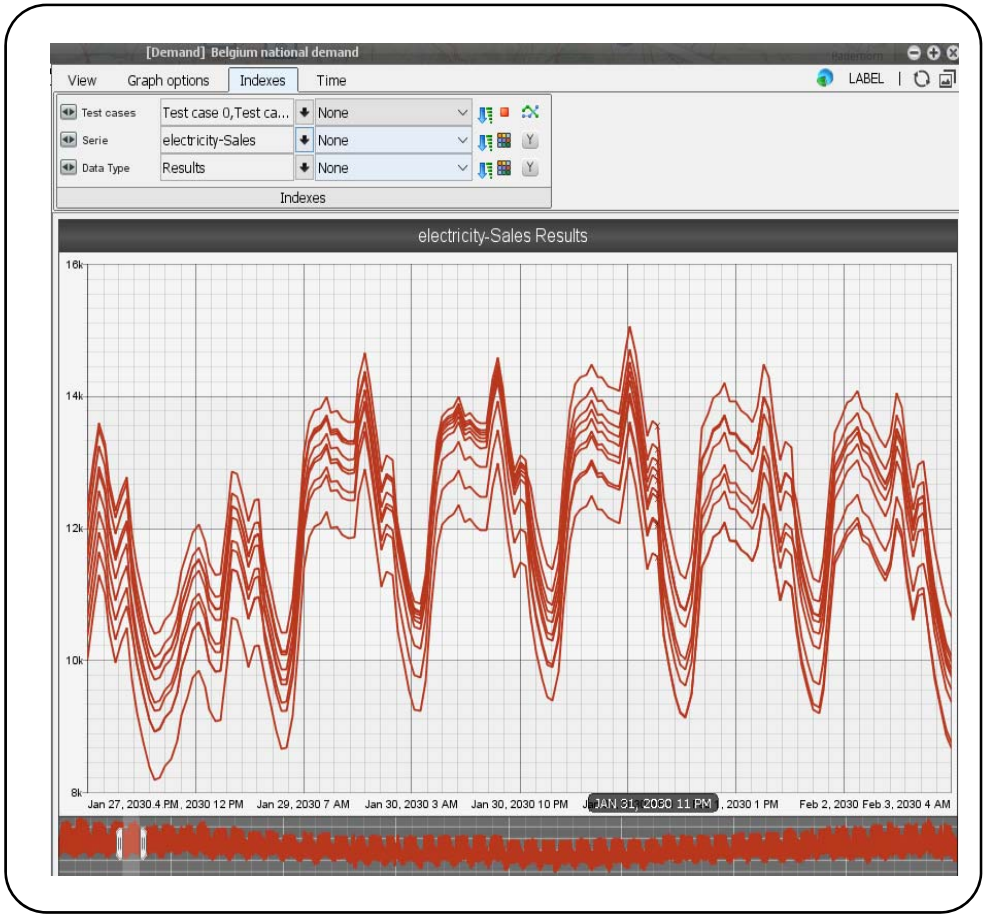
Production unit name	Type	Production capacity (MW)
AMERCOEUR 1 GT	CCGT-GT	270
AMERCOEUR 1 ST	CCGT-ST	150
ANGLEUR TG 31	CCGT-GT	39
ANGLEUR TG 32	CCGT-GT	39
ANGLEUR TV33	CCGT-ST	39
HERDERSBRUG GT1	CCGT-GT	159
HERDERSBRUG GT2	CCGT-GT	159
HERDERSBRUG ST	CCGT-ST	162
INESCO GT1	CCGT-GT	48.5
INESCO GT2	CCGT-GT	44.8
INESCO ST	CCGT-ST	44.8
KNIPPEGROEN STEG	CCGT	305
MARCINELLE ENERGIE TGV	CCGT	405
RINGVAART STEG	CCGT	357
SAINT-GHISLAIN STEG	CCGT	350
T-POWER	CCGT	425
ZANDVLIER POWER	CCGT	384
TOTAL		3381

Production unit name	Type	Production capacity (MW)
ANGLEUR TG 41	GT	63
ANGLEUR TG 42	GT	63
DROGENBOS GT	GT	230
HAM 31	GT	56
HAM 32	GT	56
IZEGEM	GT	22
TOTAL		490

Source: Elia (2016), ENGIE.

Hypotheses: Demand

- Uncertainty of future power demand
- Different test cases correlated with production profiles of vRES
- Demand response: potential of 1.6 GW with different activation prices



Source: Crystal Super Grid.

Hypotheses: Scenarios

- Based on scenarios defined in Elia (2016) and ENTSO-E (2015), SO&AF
  - Bilateral contacts with neighbouring TSO's
  - (Partial) coal and nuclear phase outs, slight increase in NGPP in EU
- 4 scenarios

Gas2017	Addinterco
Gas2017_HighCO_2	Addinterco_HighCO_2

Addinterco: +2 GW commercial capacity

_High CO_2: difference in CO_2 price

Scenario	CO_2 price (€/tCO_2)
Gas2017, Addinterco	17
_High CO_2	55

Interco analysis: Coal before Gas

C<G

Addinterco vs Gas2017

FLH decrease

M increase (but also X)

M-X increase

Less NG needed

CO_2 decrease in BE (but increase in EU)

System MC decrease

	Unit	Gas2017	Addinterco
FLH	*h*	4739	4507
M	*TWh*	32.8	35.8
X	*TWh*	2.9	5.1
M-X	*TWh*	29.9	30.7
NG	*TWh-GCV*	33.2	31.5
System MC	*€/MWh*	71.1	70.7

Source: Crystal Super Grid, FPB.

+7.4 M€

M-X: +56 M€

NG: -49 M€

Interco analysis: Gas before Coal

G<C

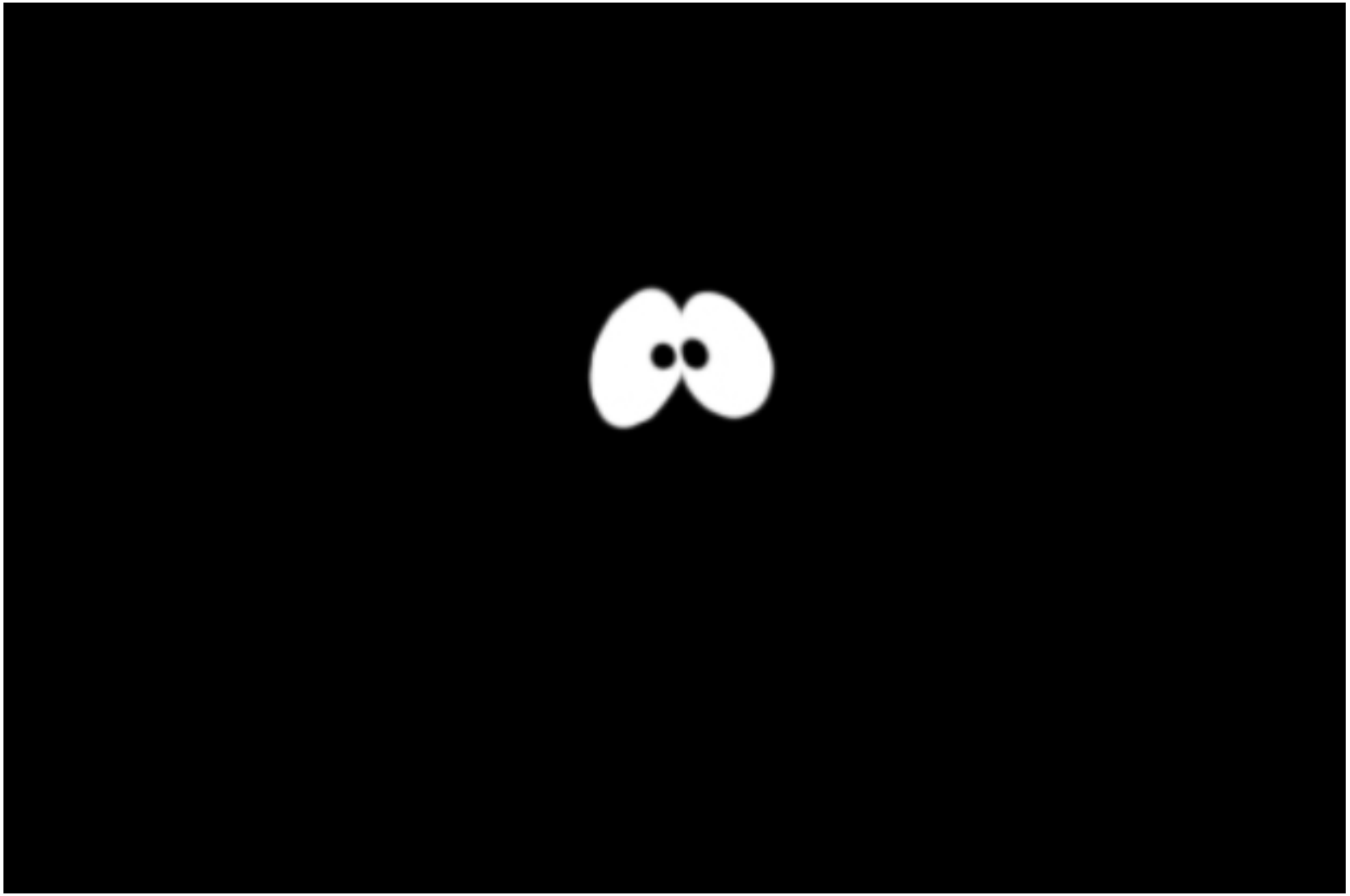
Addinterco_HighCO_2 vs Gas2017_HighCO_2

- FLH stable (but way higher than C<G)
- M and X increase
- M-X stable (but much lower than C<G)
- Supply of NG stable
- CO_2 quasi stable in BE (but decrease in EU)
- System MC decrease

	Gas2017_HighCO_2	*Addinterco_HighCO_2*
FLH	7656	7667
M	31	35.5
X	11	15.5
M-X	20	20
NG	53	53
System MC	97.1	96.8

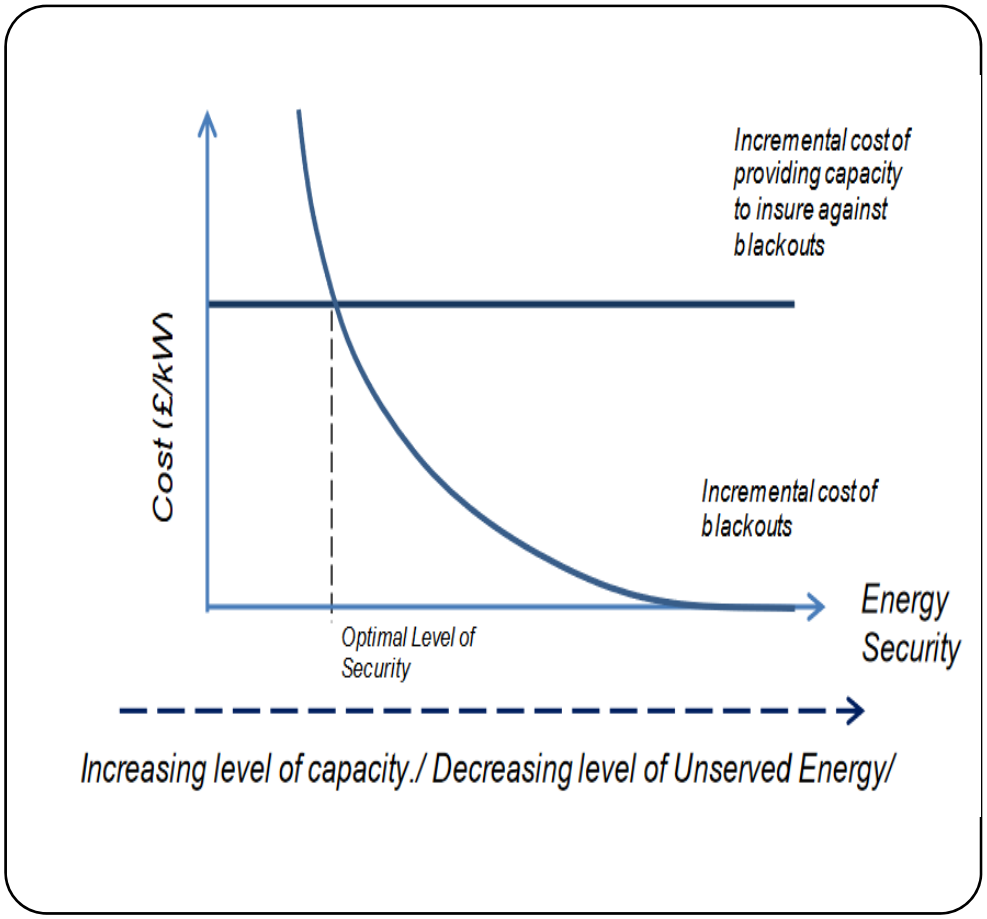
Source: Crystal Super Grid, FPB.

IA of an increased risk of black-out



IA of an increased risk of black-out (2)

- Reliability standard for contracting capacity in the UK Capacity Market
- Increased risk of black-out, adequacy calculations
- CONE=LOLE*VOLL
- If CONE<LOLE*VOLL=> capacity should be added



Source: DECC (2013).

IA of an increased risk of black-out (3)

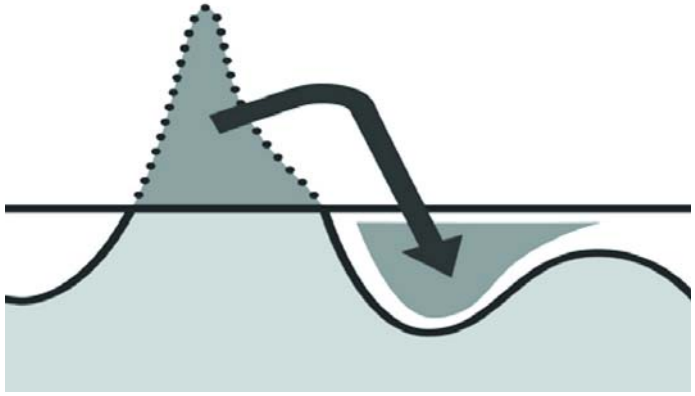
- Reliability standard for contracting capacity in the UK Capacity Market
- Increased risk of black-out, adequacy calculations
- CONE=LOLE*VOLL
- If CONE<LOLE*VOLL=> capacity should be added

	BE value	Unit
LOLE Gas2017	2.6	*h*
LOLE Minus 1	3.1	*h*
VOLL	23.3	*€/kWh*
CONE	65	*€/kW*

Source: Crystal Super Grid, FPB.

IA of an increased risk of black-out (4)

- If one or more CCGT closes, GA will be jeopardized
  - Prevent the CCGT from leaving the market: SR?
  - Trigger investments in new OCGT
- Demand Response to the rescue: if price DR < 65 €/kW



Key findings

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- Major impact of a fair carbon price
  - Favours domestic production of CCGT: higher FLH, more exports
  - Triggers higher inframarginal rents
  - Increasing interco's:
    - C<G: BE becomes electricity roundabout
    - G<C: BE profits more through increased exports
- Major impact of regulatory & policy decisions

  Price caps, nuclear phase-out, …
- Missing Money: only missing in case of C<G
- Generation adequacy:
  - Assured if capacity of thermal flexible park 2017 is kept online
  - If not -> trigger investments in OCGT/DR/combination

Thank you!

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