Gate 3 Workshop

Description of Constraints Analysis Methodologies

EirGrid Offices

2nd April 2009

Eoin Kennedy
Generation Analysis,
EirGrid

Contents

- Introduction to Constraints Modelling
- Common Assumptions
- Wind Generation modelling
- Conventional Generation modelling
- Other Issues
- Summary

Irish Power System

- 6,000 MW Conventional
- 1,000 MW wind (increasing)

- RoI Peak 4,900 MW
- RoI Annual Production 28 TWh

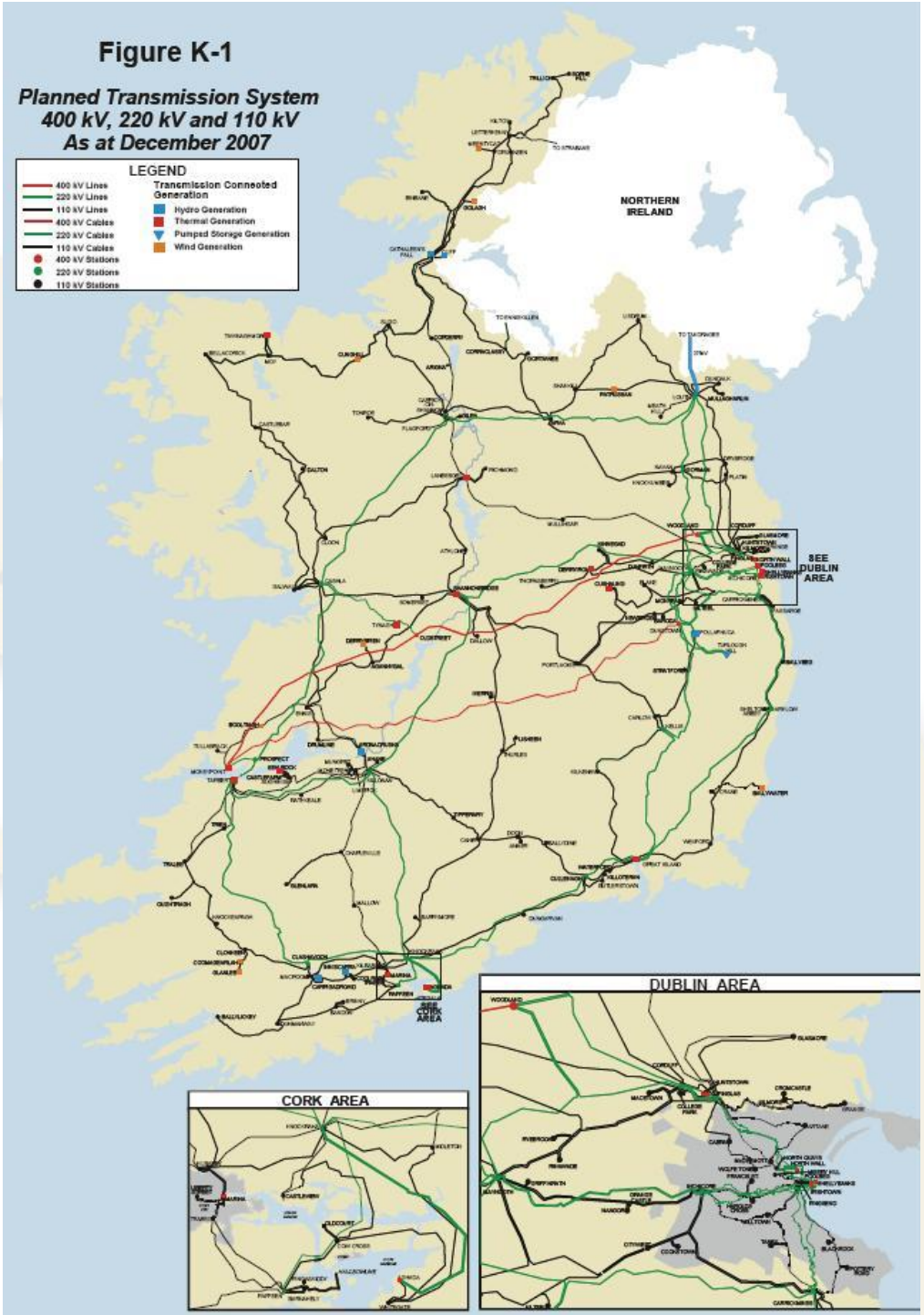
- Transmission Stations 113

- 110kV Feeders 3956 km*
- 220kV Feeders 1829 km*
- 400kV Feeders 439 km*

- 3 Interconnections to NIE

* Transmission Forecast Statement 2008 - 2014

EIRGRID

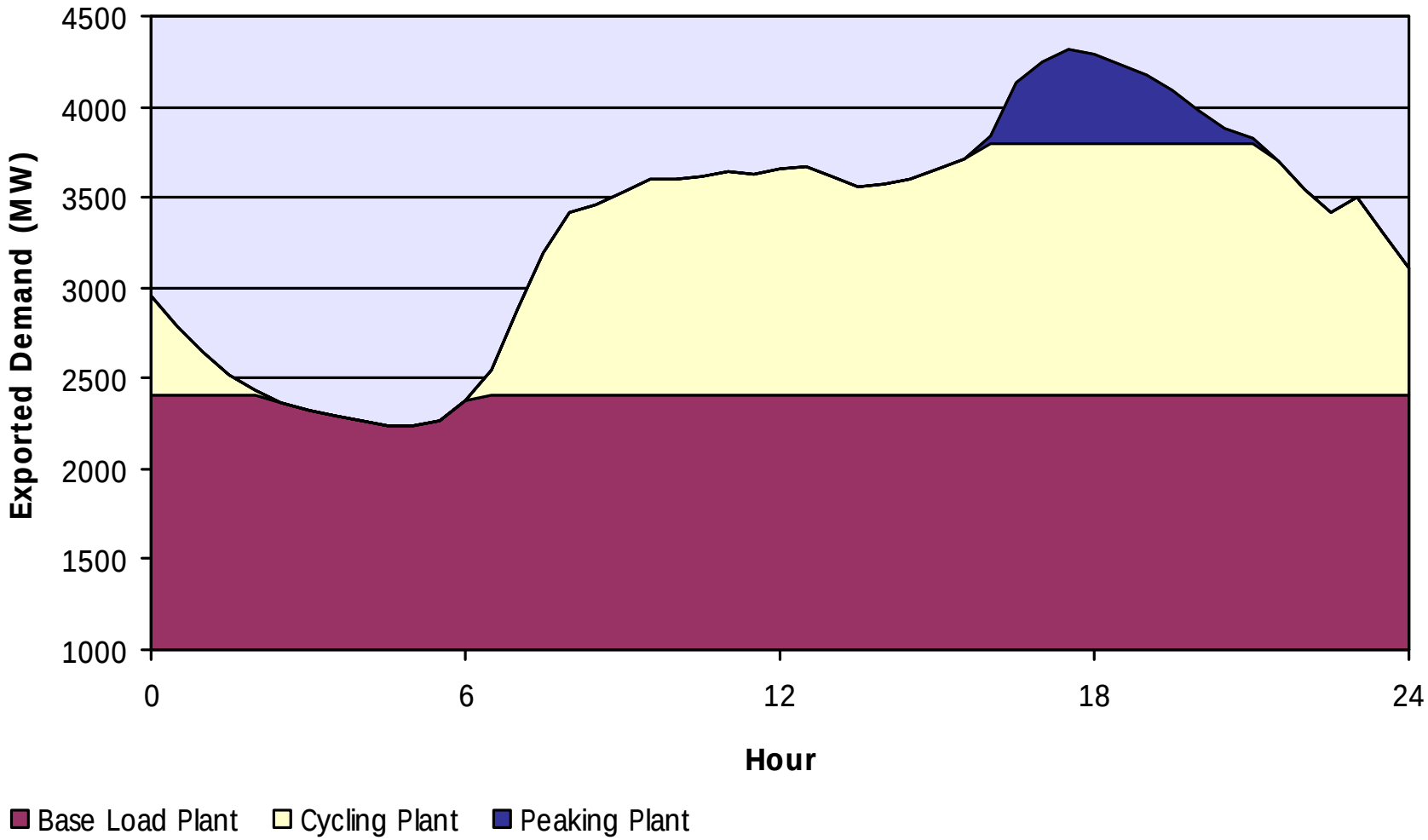


Basic Definitions

- Unit commitment
  - The decision about which generator should be brought on and taken off (and at what time) to minimize system costs subject to security constraints.

- Economic dispatch
  - The decision as to how to meet customer demand from the generators which are on load.

Typical daily load shape



Description of Constraints Modelling

- PROMOD is the software tool employed.
  - Chronological Unit Commitment Economic Dispatch (UCED) model.
  - Simulates the operation of the power system.
  - 8760 hours modelled per year
- Relative efficiencies (operating costs) of the generating units are used to match generator output with electricity demand in the most economical manner.

EIRGRID

Chronological UCED models

- Objective functions
  - Minimise the system cost (fuel bill/operating costs)
  - Recognise system constraints such as spinning reserve, generator capabilities, transmission network limitations etc.

Approach - multiple pass

- First pass – annual time frame
  - Schedule generator maintenance to levelise risk
- Second pass – weekly time frame
  - Generate indicative commitment pattern
  - Generate indicative cost curves
- Third pass – hourly time frame
  - Random generator forced outages
  - Hourly commitment decisions
  - Economic dispatch

EIRGRID

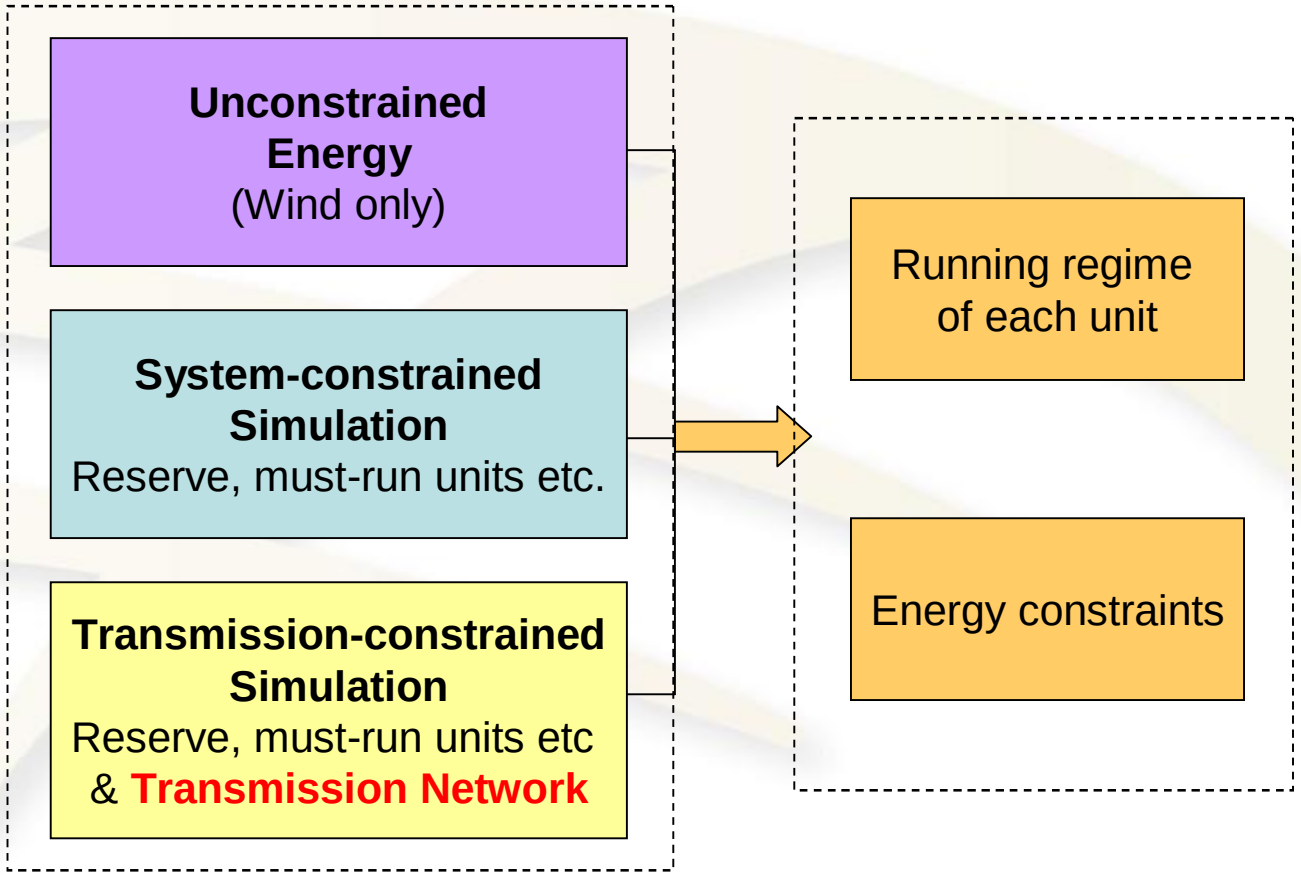
Inputs

- Demand shape
- Generator characteristics
  - Forced outage rate
  - Scheduled outage requirement
  - Minimum run/down times
  - Ramp rates
  - Generator capacity
  - Heat rate curves
- Fuel prices
- System constraints
- **Transmission network**

Outputs

- Hourly generation pattern for each generator
  - Number of start-ups, loading patterns etc.
- System/Fuel cost
- Fuel consumption by fuel type
- Emission quantities
- Transmission line loadings

Constraints Methodology



Constraints Methodology

- System-constrained simulation takes into account system constraints like reserve, must-run units etc.
- Transmission-constrained simulation takes into account system constraints **and** transmission network limitations.
- For each generator, the difference between their output energy for these two simulations is the constrained-off energy due to transmission network limitations.

EIRGRID

Common Assumption

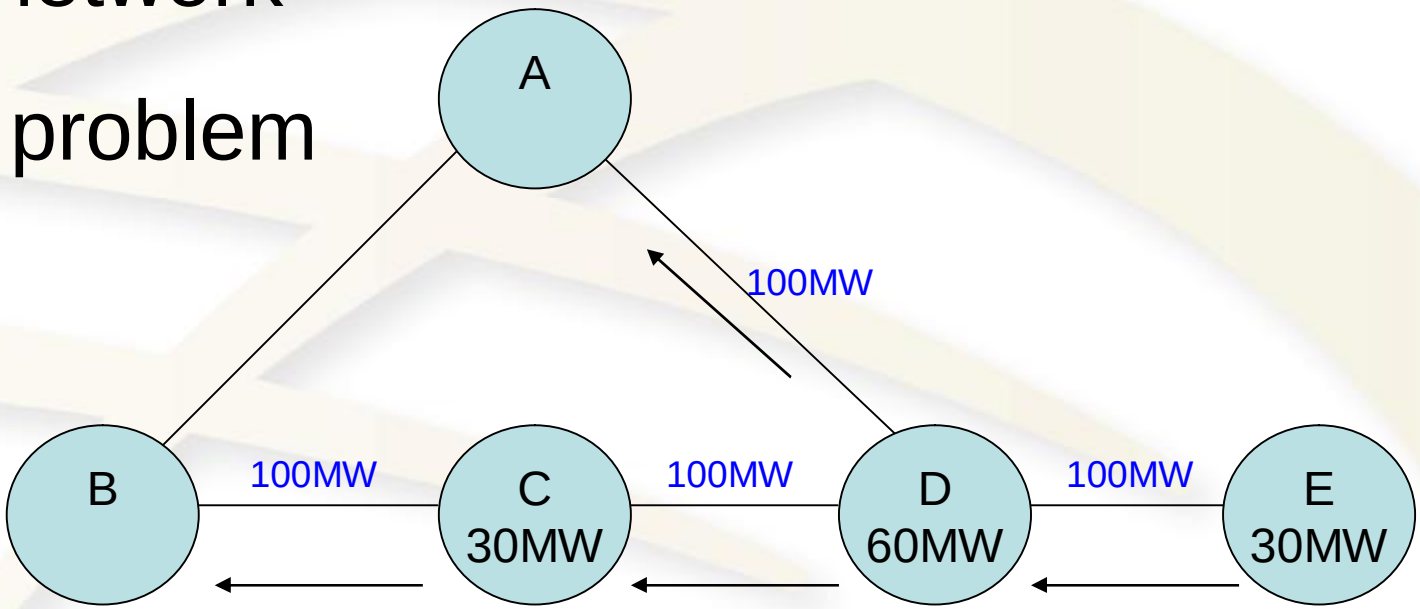
- N-1 study.
- Annual studies.
- Demand base year 2008 (tbc).
- Demand growth as per ITC assumptions.
- Same fuel/carbon prices for each year to be studied.
- Constraints report for each year for each applicant.
- Transmission reinforcement as per ITC assumptions (except for full year).
- No transmission maintenance outages.
- Generator shallow connections as per standard lead-times.
  - DSO will deliver by June 2009
- CER decision on transmission access rights delivered by end July 2009.
- CER decision on access rights can be modelled in PROMOD by end September 2009.

EIRGRID

N-1 Example

Intact network

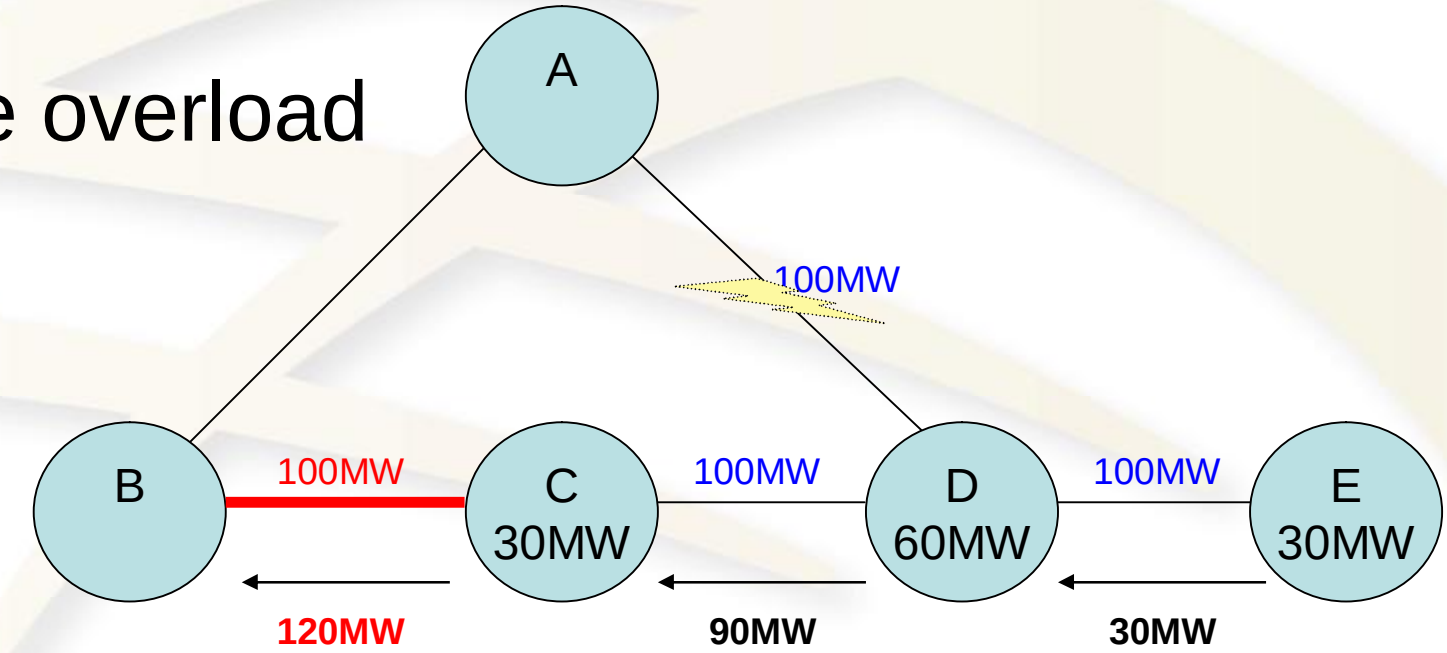
=> No problem



N-1 Example

N-1

=> Line overload



Timetable

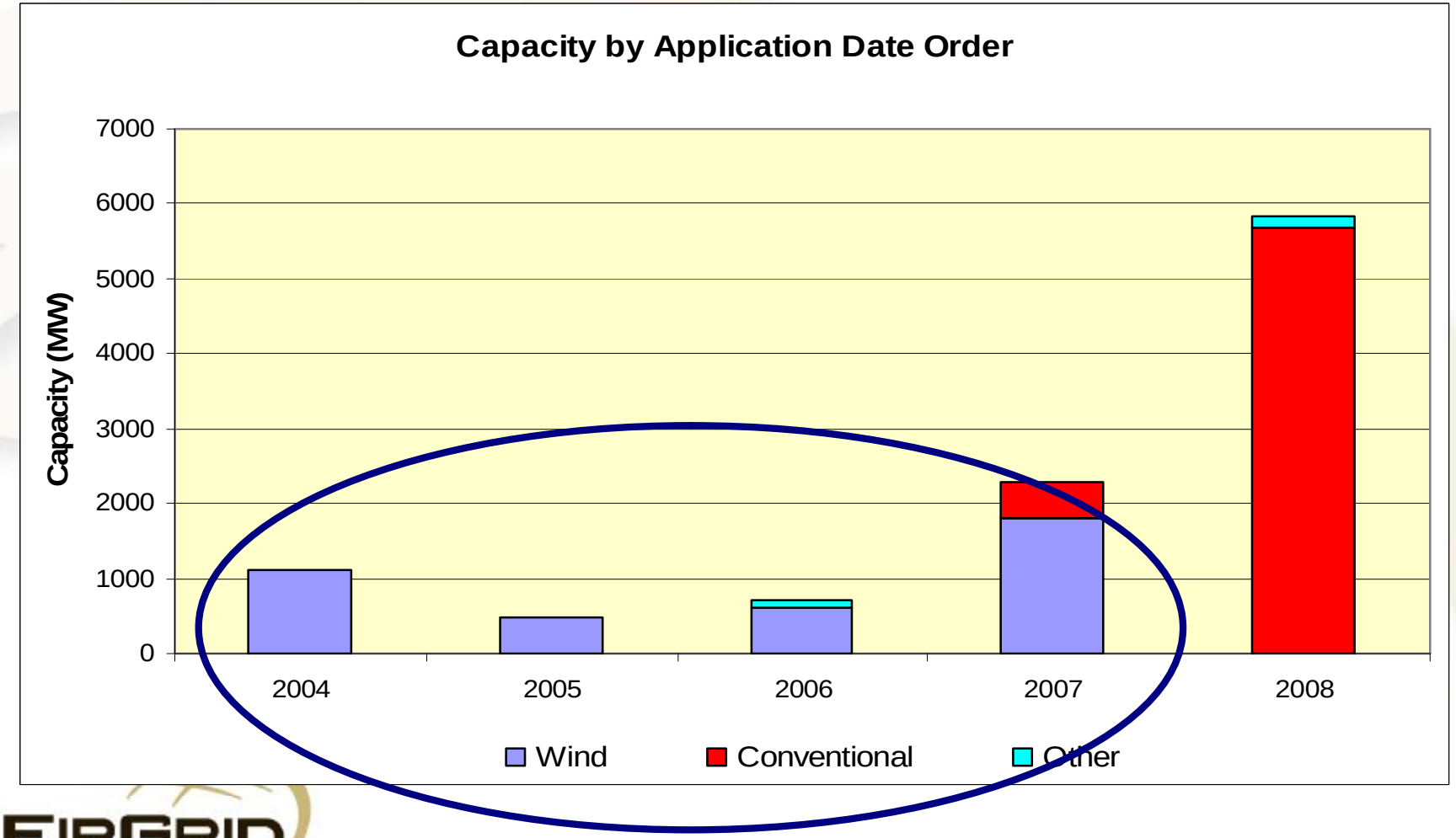
Task	Start	Finish
Preparatory work	5th Jan 2009	31st July 2009
Develop Constraints Report Format	5th Jan 2009	29th May 2009
Setup Model based on new CER/NIAUR Transmission Access Rights rules	4th Aug 2009	30th Sept 2009
Run Constraints Model for each year (10 years)	1st Oct 2009	18th Dec 2009
Generate Constraints Results for each Applicant and Produce Reports	4th Jan 2010	15th June 2011

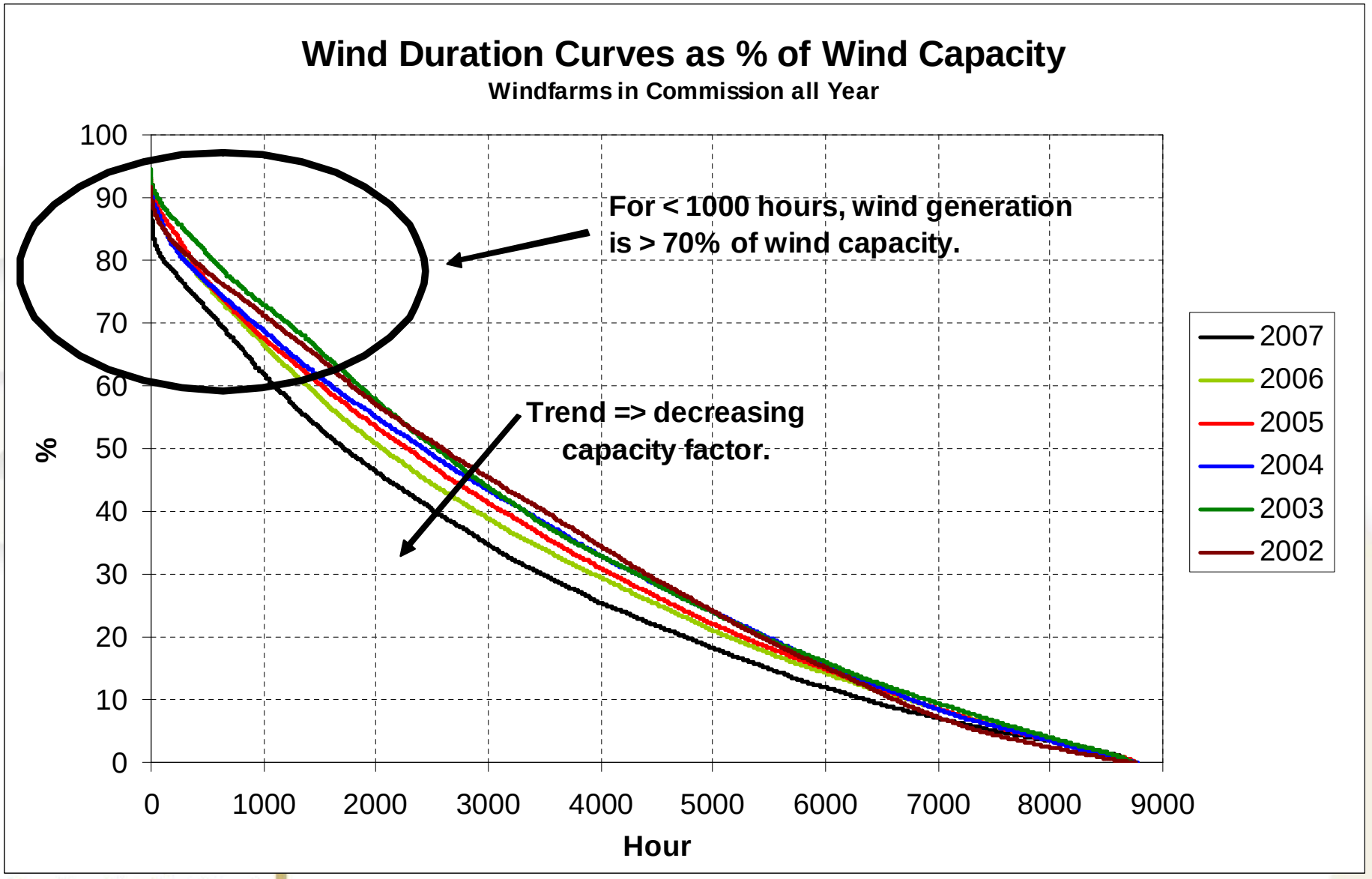
EIRGRID

Wind Generation Modelling

EIRGRID

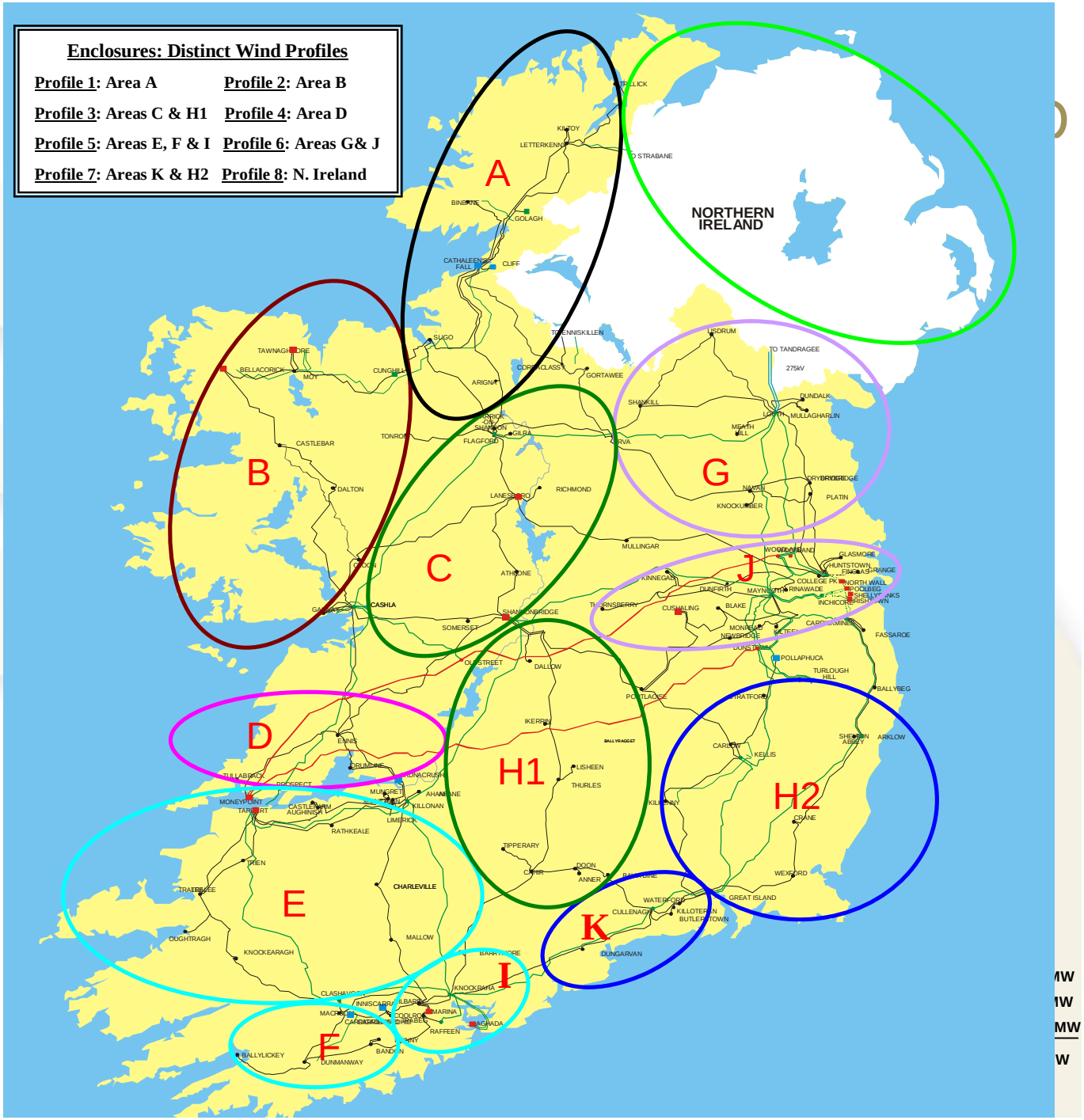
Date Order


Capacity by Application Date Order
Capacity (MW)
7000
6000
5000
4000
3000
2000
1000
0
2004
2005
2006
2007
2008
Wind
Conventional
Other


Wind Duration Curves as % of Wind Capacity
Windfarms in Commission all Year
For < 1000 hours, wind generation is > 70% of wind capacity.
Trend => decreasing capacity factor.
%
Hour
100
90
80
70
60
50
40
30
20
10
0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
2007
2006
2005
2004
2003
2002

EIRGRID

- Amalgamation of wind farms by transmission node and category
  - Pre-gate 2
  - Gate 2 Firm
  - Gate 2 non-firm
  - Gate 3 firm
  - Gate 3 non-firm
- Exact wind farm categories to be used will be influenced by CER decision.
- Identical wind power series profile (based on 2008 wind profile (tbc) and scaled by MW value) allocated to every wind farm category at each transmission node in an area.

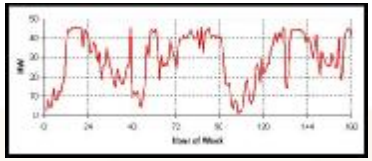


Wind Modelling

- Wind farm categories modelled in PROMOD as low, slowly increasing costs to differentiate (hierarchy of wind farm categories will be influenced by CER decision on access rights).
  - Pre-Gate 2
  - Gate 2 firm
  - Gate 3 firm
  - Gate 2 non-firm
  - Gate 3 non-firm
- As wind generation is cheapest, PROMOD will schedule the wind (regardless of Gate) to run ahead of everyone else and constrain it only when it is the most cost-effective solution to mitigate transmission overloads.
- PROMOD will constrain the most expensive wind transaction first.
- The fact that a wind farm is granted firm capacity does not mean that the level of constraint is zero. There will often be a small amount of constrained-off output.

EIRGRID

Example (for illustration purposes only)



Pre-Gate 2: 1€/MWh

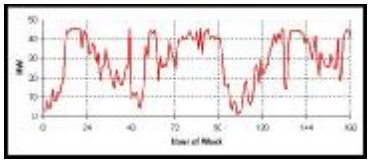
Capacity: 20 MW

Unconstrained energy: 60GWh

Post-constrained energy: 60GWh

Constraints: 0GWh

Constraints: (0/60)*100= 0%



Gate 2 Firm: 1.1 €/MWh

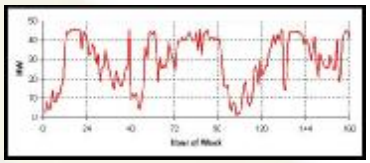
Capacity: 25 MW

Unconstrained energy: 75GWh

Post-constrained energy: 74GWh

Constraints: 1GWh

Constraints: (1/75)*100= 1.3%



Gate 3 Firm: 1.2 €/MWh

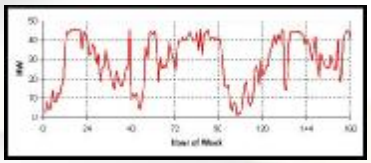
Capacity: 40MW

Unconstrained energy: 120GWh

Pos-constrained energy: 118GWh

Constraints: 2GWh

Constraints: (2/120)*100= 1.7%



Gate 3 Non-Firm: 1.4 €/MWh

Capacity: 60MW

Unconstrained energy: 180GWh

Post-constrained energy: 120GWh

Constraints: 60GWh

Constraints: (60/180)*100= 33%

TX Node

Gate 2 Non-Firm: 1.3 €/MWh

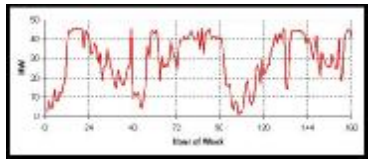
Capacity: 0MW

Unconstrained energy: N/A GWh

Post-constrained energy: N/A GWh

Constraints: N/A GWh

Constraints: N/A



Wind Modelling Assumptions

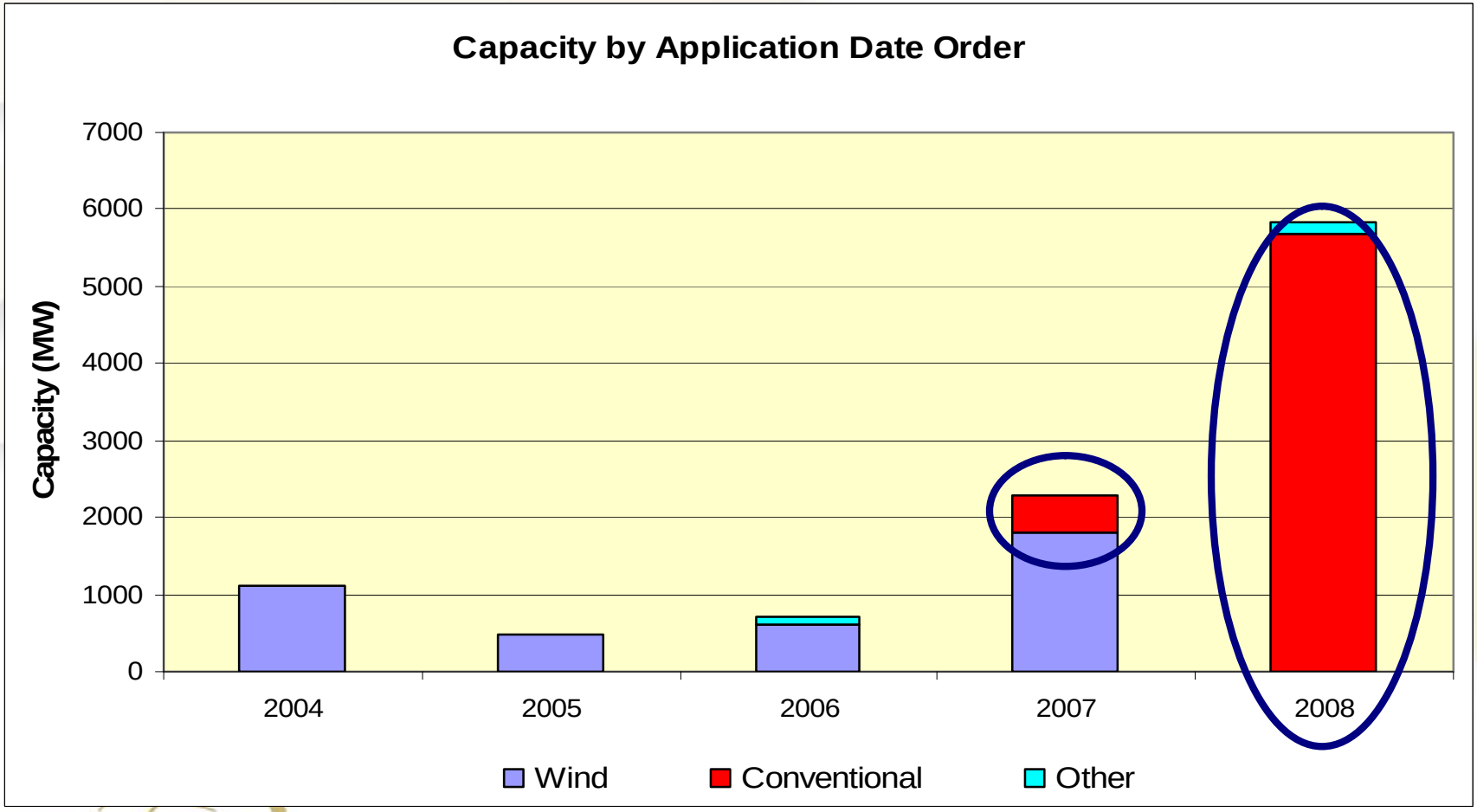
- Wind base year 2008 (to be confirmed)
- No interconnection flow assumed in base case.
  - Effect of interconnection will emerge during interconnector constraints modelling.
- One scenario will be studied.
  - All accepted Gate 2
  - 100% Gate 3?

EIRGRID

Conventional Generation Modelling

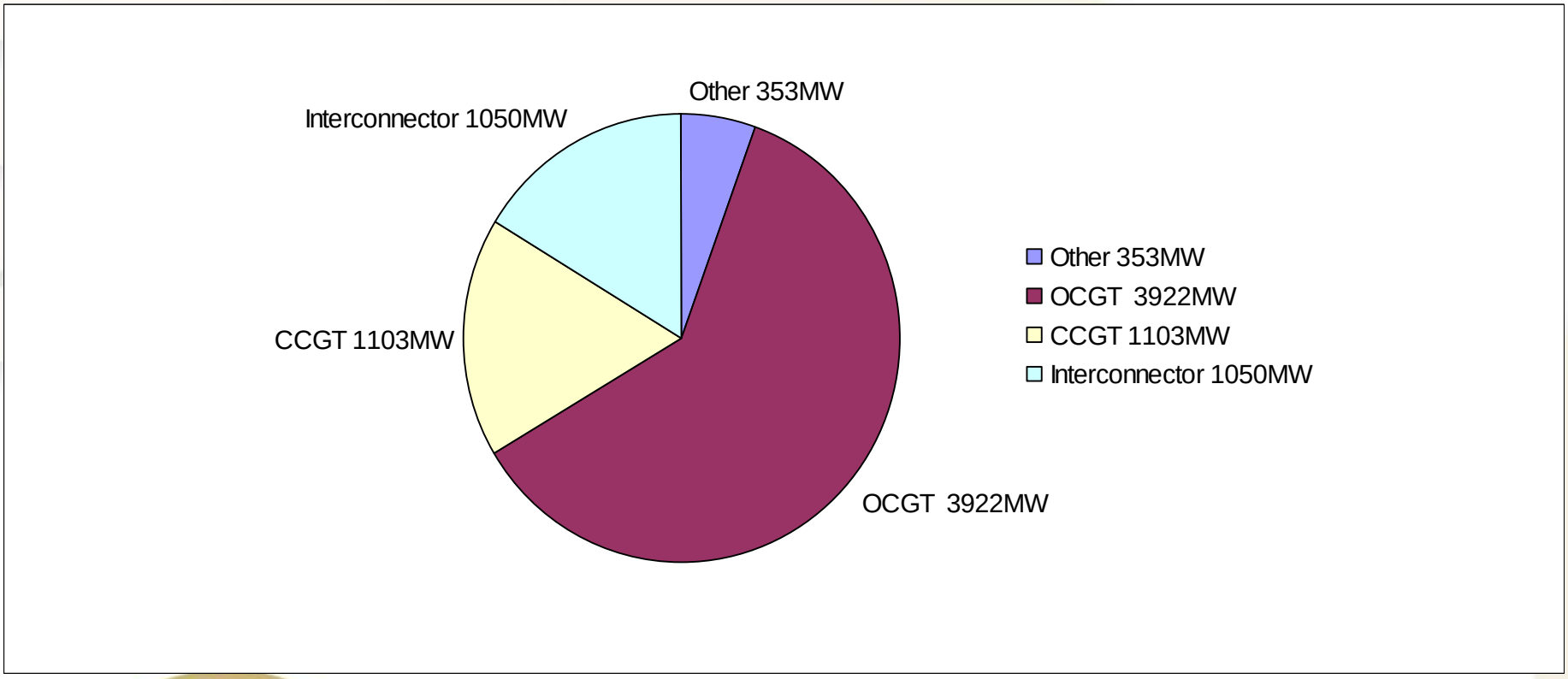
EIRGRID

Date Order


Capacity by Application Date Order
Capacity (MW)
7000
6000
5000
4000
3000
2000
1000
0
2004
2005
2006
2007
2008
Wind
Conventional
Other

Plant Portfolio Considerations

Conventional Generation Applications by generator type



Conventional Generation

- CER consultation on conventional generation application treatment.
- Constraint report for 6500MW conventional generation is problematic and may be meaningless.
  - Most low merit plant will not run
  - Very sensitive to efficiency of high-merit plant.
- EirGrid Proposal
  - Perform constraints analysis only for those generators who will receive an offer.

Other issues

- Operational rules
  - Will reflect EirGrid policies on spinning reserve, minimum number of conventional generators synchronised etc.

Summary

- Aim is to give meaningful constraint information to applicants
  - Reviewing assumptions with industry
- Different groups require different treatment
  - Wind
  - Conventional
- Technically complex process
  - Transmission Access Rules decision is key

EIRGRID

Thank You

Eoin Kennedy
eoin.kennedy@eirgrid.com

www.eirgrid.com

EIRGRID