

Synchronisation Challenges for SmartGrid

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Dr. Hugh Melvin, NUI Galway : ITSF
Dublin 2010

Outline

- Time & Timing within Power Systems
- SmartGrid
- Synch challenges for SmartGrid
- Conclusions

Time & Timing within Power Systems

- Background in Power Generation
- Aghada
 - Conventional Gas Fired + CCGT
- Tarbert
 - Conventional Oil fired
 - Now owned by Endesa
- Moneypoint
 - Conventional Coal fired 1000 MW

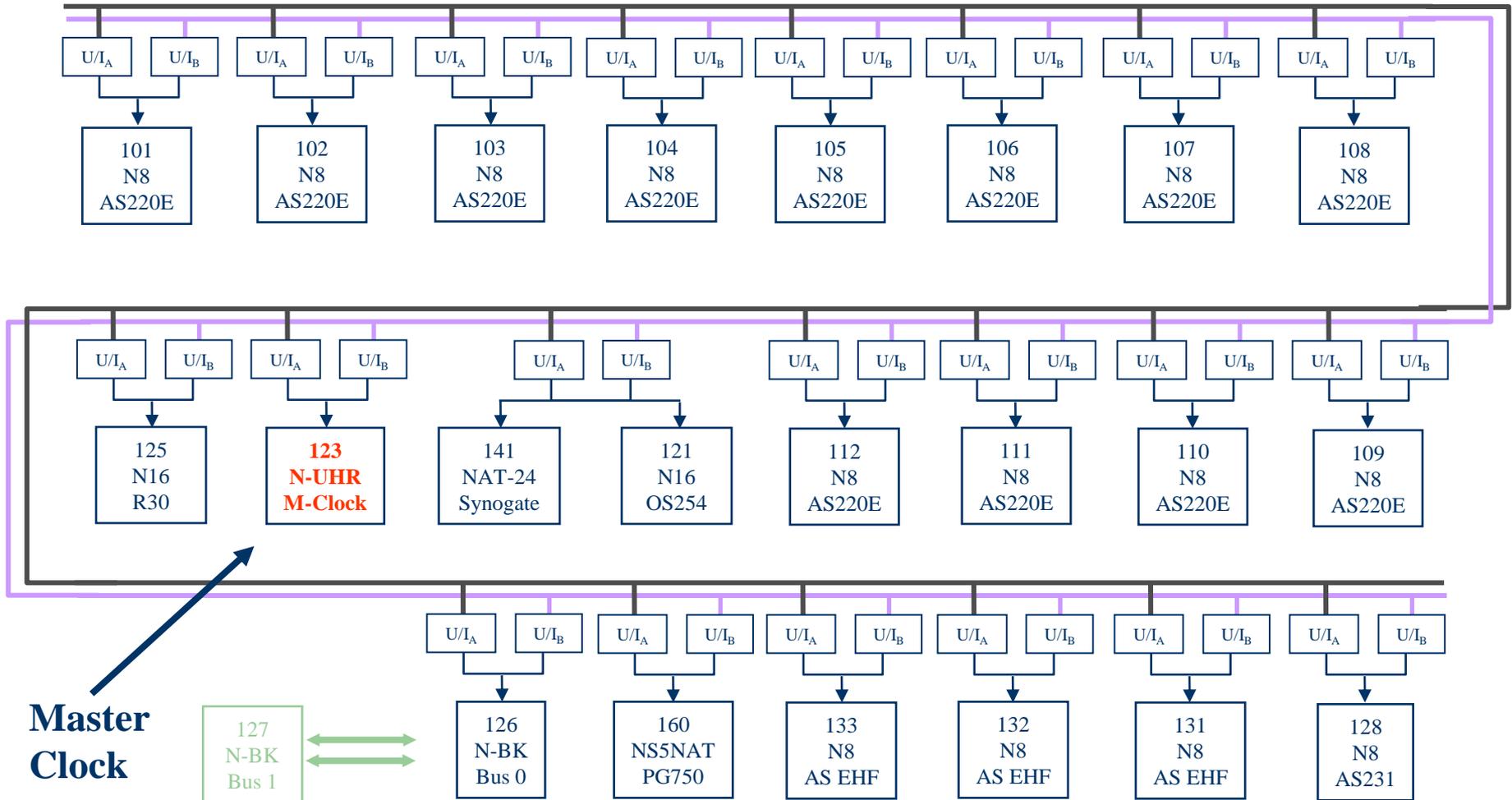


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Time & Timing within Power Systems

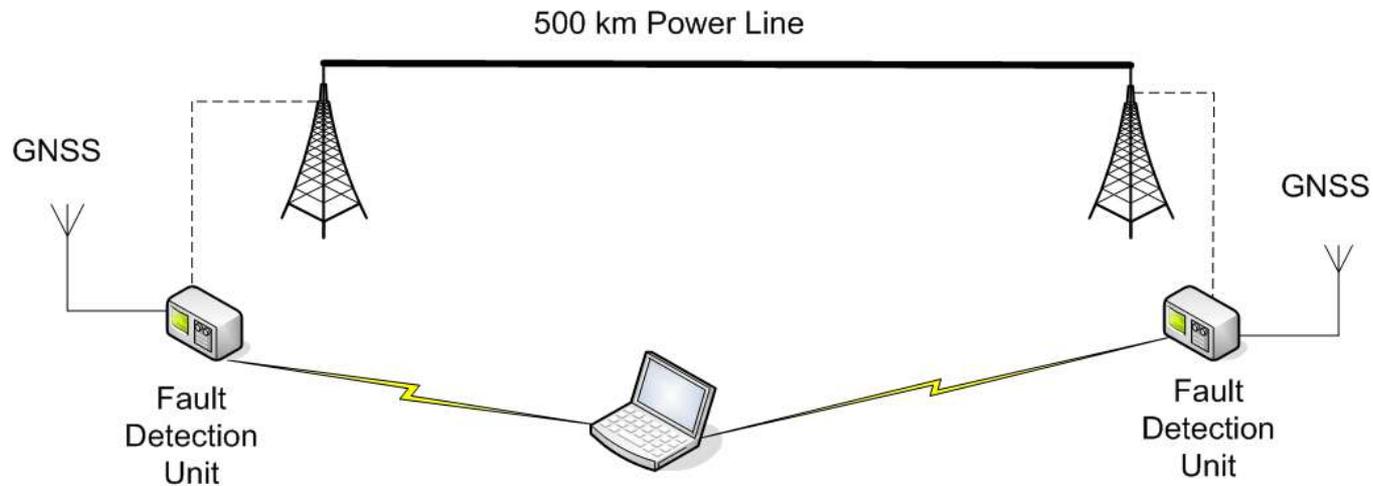
- Time Synch
 - Distributed Control System
 - Millisecond level reqd for precise chronological event diagnosis
 - Power Line Fault Detection
 - Microsecond or better
 - SCADA systems
- Timing Synch
 - 2v3 voting systems
 - Generator synch to transmission network

Original System (largely replaced)

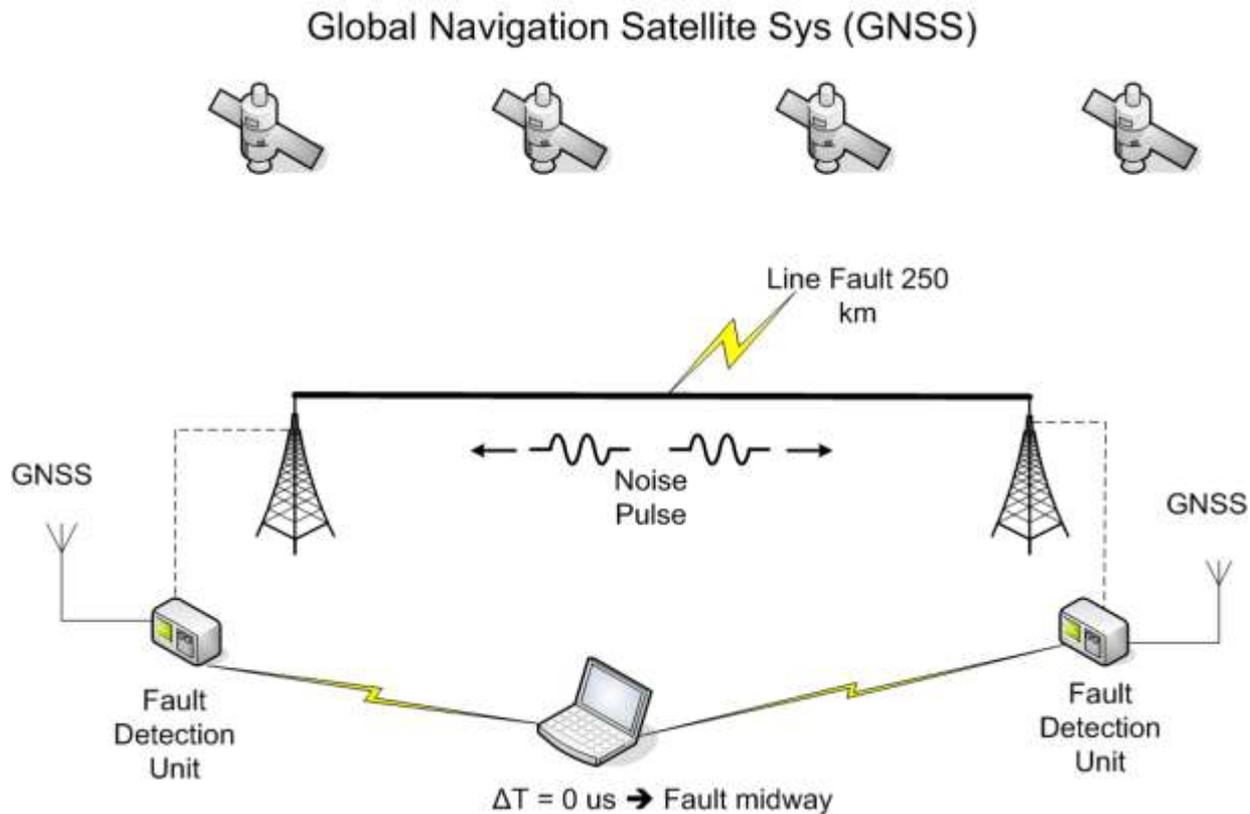


Power Line Fault Detection System

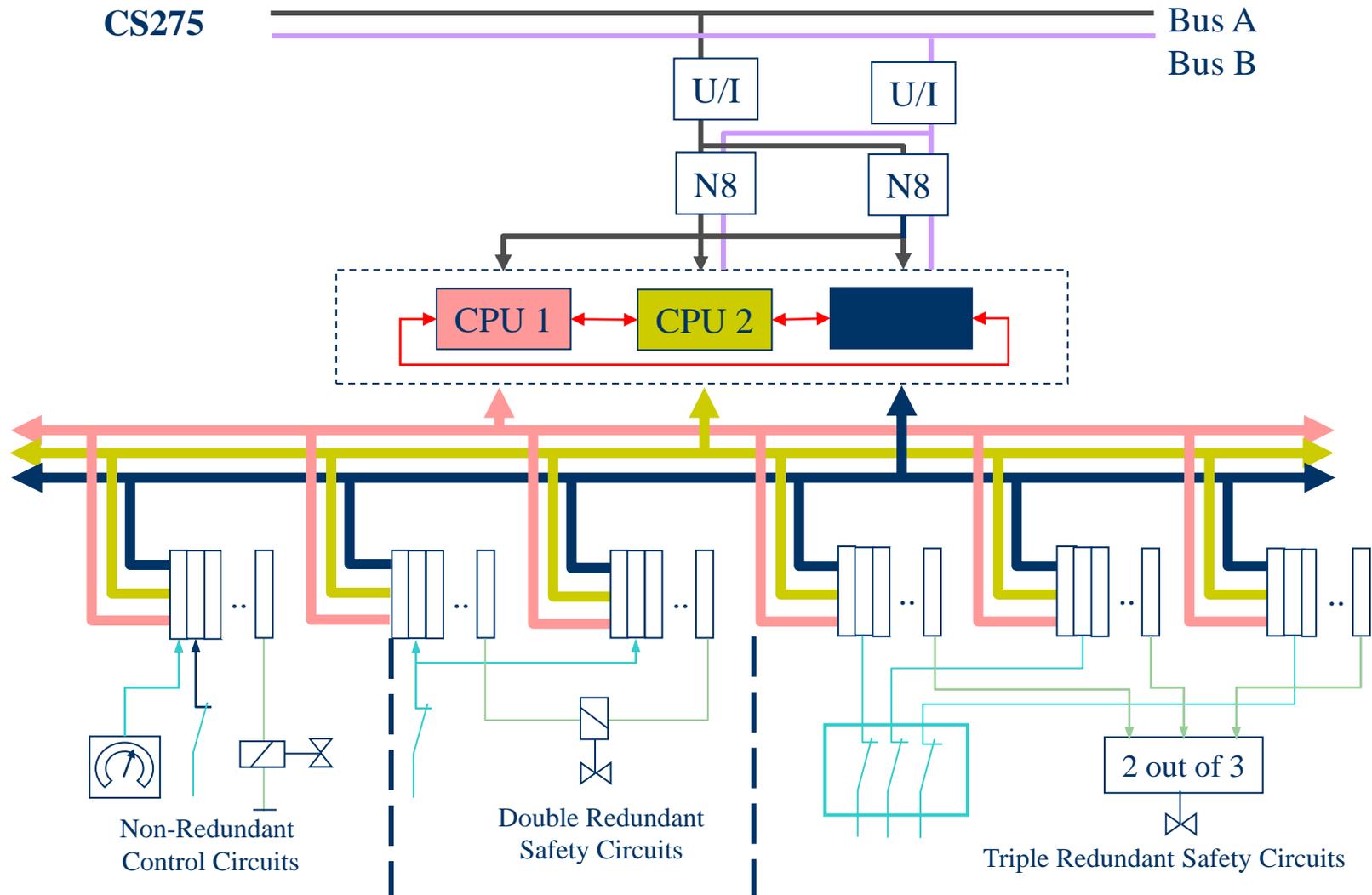
Global Navigation Satellite Sys (GNSS)



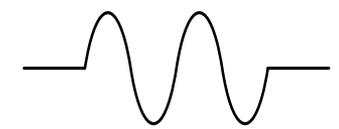
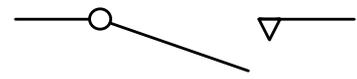
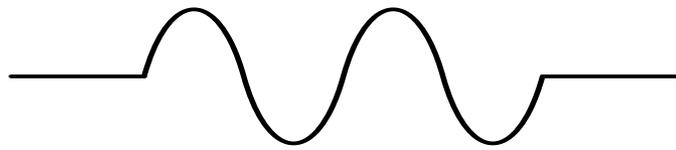
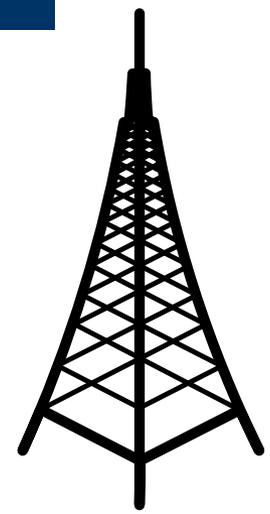
Power Line Fault Detection System



Timing Synch 2v3 Redundancy



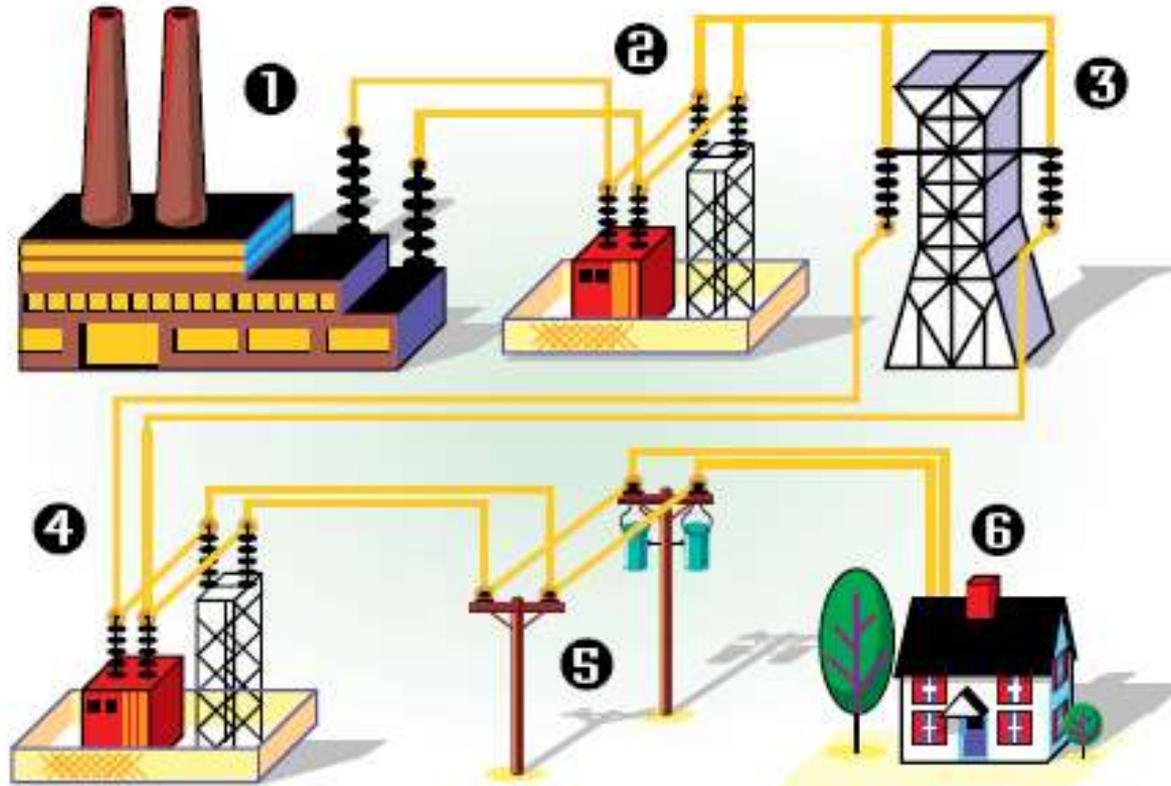
Synchroscope



SCADA

- Supervisory, Control & Data Acquisition
- Key component of Electrical Grid Infrastructure
 - 2 parallel networks
 - Transmission lines (LV/MV/HV)
 - Associated SCADA communications infrastructure

Traditional Grid (src: Mick Mackey ESBI)



Traditional Grid

- One directional & predictable power flows
- Generator → HV → MV → LV → Consumer
- SCADA
 - Limited need for data communications

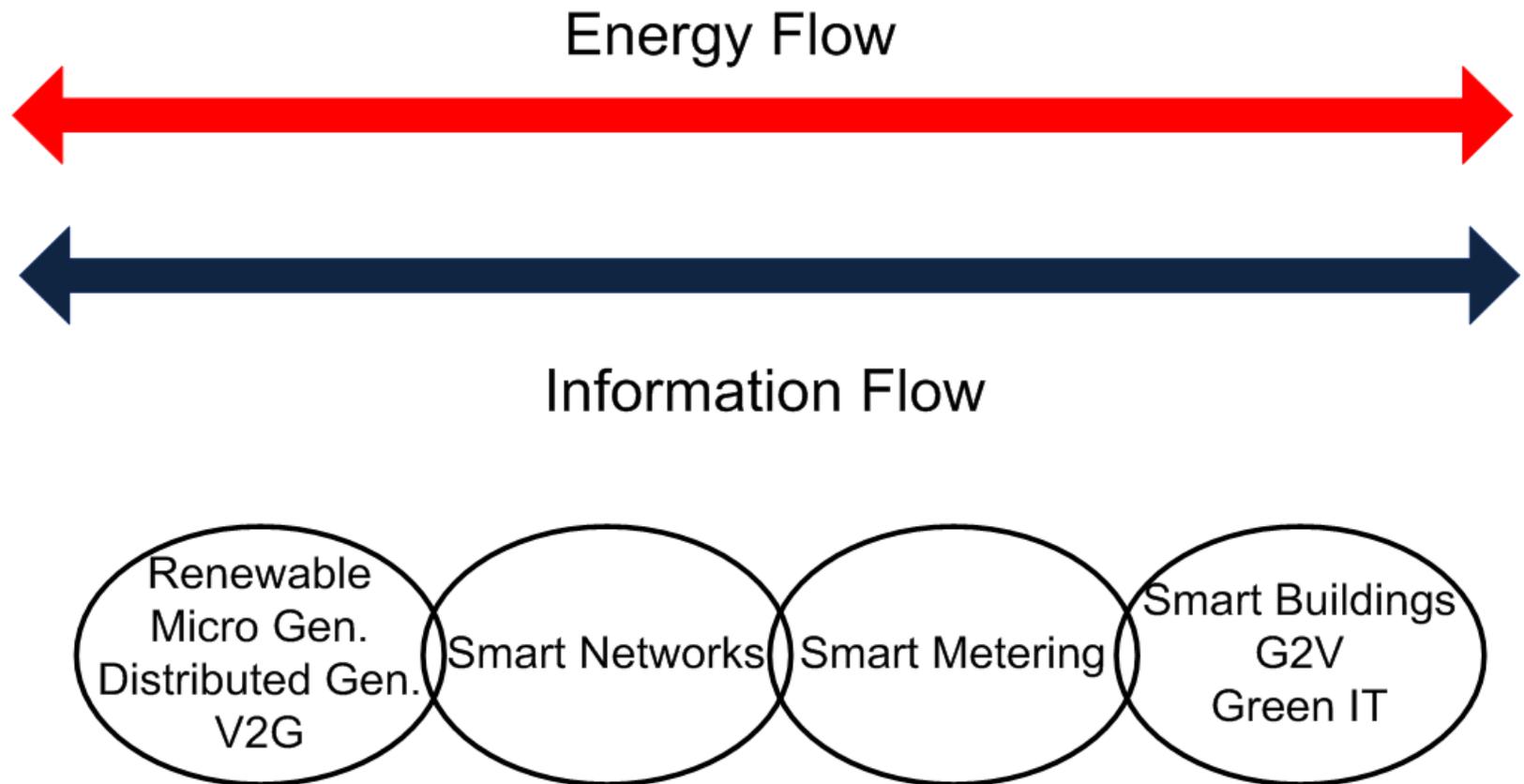
Smart Grid : Definition ?

- Visionary → Revolutionary
 - Complete Infrastructural Overhaul
- Engineer → Evolutionary
 - By necessity
 - Continuity, Robustness, Safety Critical concerns

Smart Grid : Context

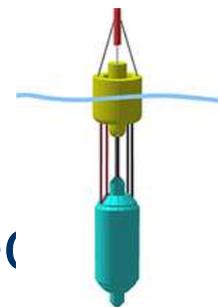
- Over-reliance on fossil fuel sourced energy
- Diminishing fossil fuel reserves
 - Focus on renewables
- Security of supply
- Deregulation
- Environmental Concerns

Smart Grid : ICT Enabled



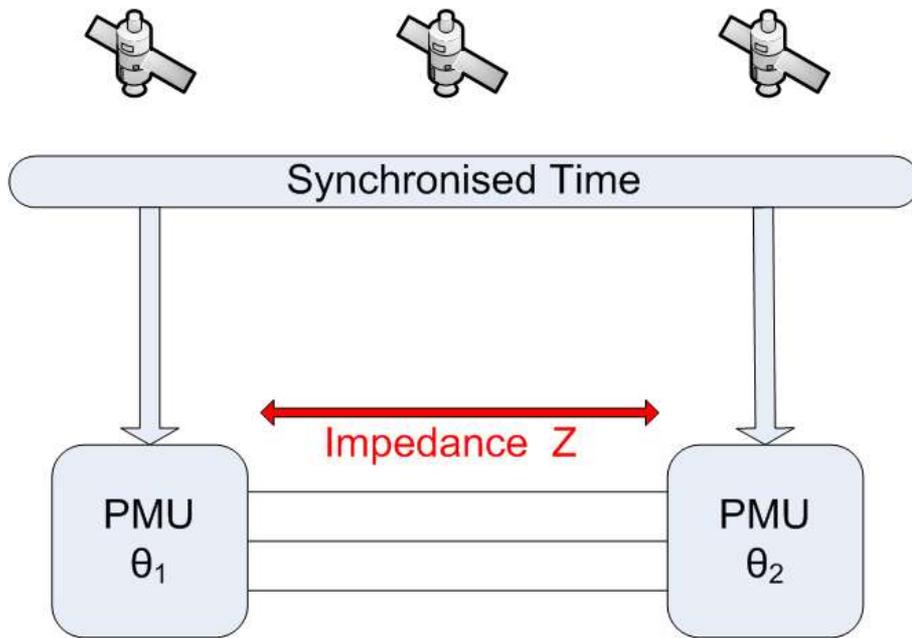
Generation

- Renewable
 - Predictable ?
- CHP
- Microgeneration
- V2G
 - Distributed generation
 - New grid design & operation required
- Grid Infrastructure Investment



Smart Networks

- Radically different generation landscape
- Much more dynamic
- Need for precise realtime measurement, control & protection
- Hierarchical SCADA systems
- Phasor Measurement Units

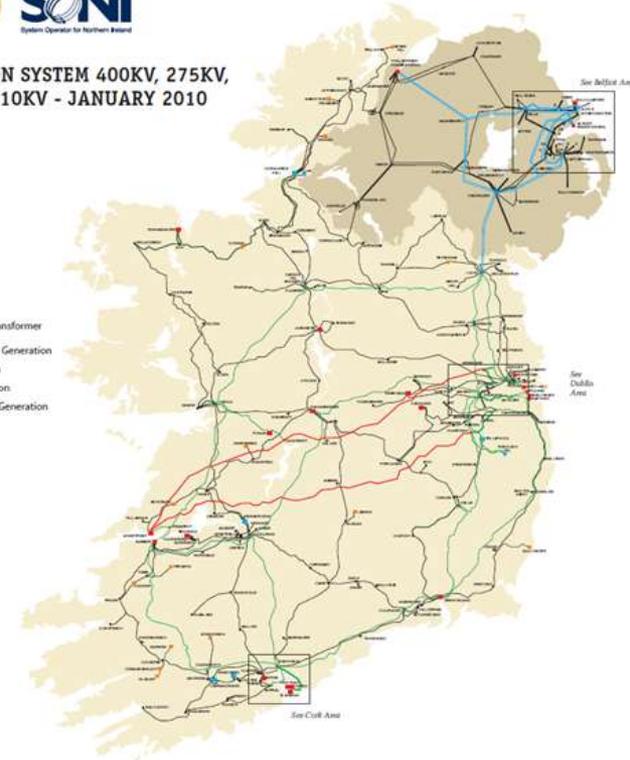


$$P = V_1 V_2 \sin \Delta \theta / Z$$



TRANSMISSION SYSTEM 400KV, 275KV, 220KV AND 110KV - JANUARY 2010

- 400kV Lines
- 275kV Lines
- 220kV Lines
- 110kV Lines
- 220kV Cables
- 110kV Cables
- 400kV Stations
- 275kV Stations
- 220kV Stations
- 110kV Stations
- ⊗ Phase Shifting Transformer
- Transmission Connected Generation
- Hydro Generation
- Thermal Generation
- ▼ Pumped Storage Generation
- Wind Generation



Smart Metering

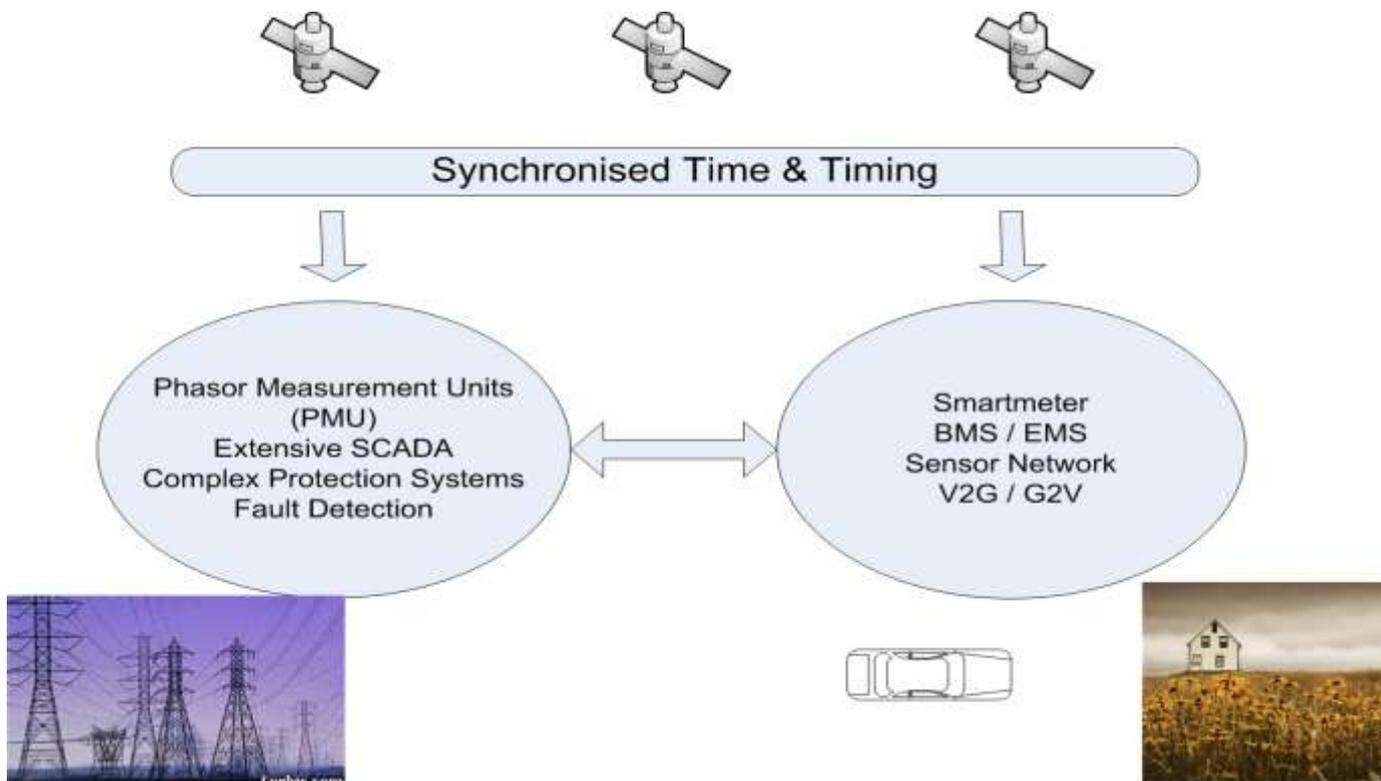


- *You cannot control what you don't understand*
- Realtime energy demand profile
- Realtime pricing
- Realtime incentives

Smart Buildings

- *You cannot control what you don't understand*
- Energy Management Systems
- Building Management Systems
- Demand Side Management
- Sensor networks

Smart Grid : Synch Requirements



Conclusion

- SmartGrid is multi-faceted & ambitious
- Iterative deployment likely
- ICT is key enabler
- Time & Timing Synch are critical
- ESB Networks at forefront of SmartGrid deployment

Integrated Smart Networks

Operational Challenges

A young child with short brown hair is shown in profile, blowing a bubble. The background features a coastal landscape with several white wind turbines under a blue sky with white clouds. The child is wearing a red and white striped shirt.

We're investing in
the next generation

Rónán ÓhÓgartaigh,
Operations Manager,
Asset Management,
ESB Networks.



Networks

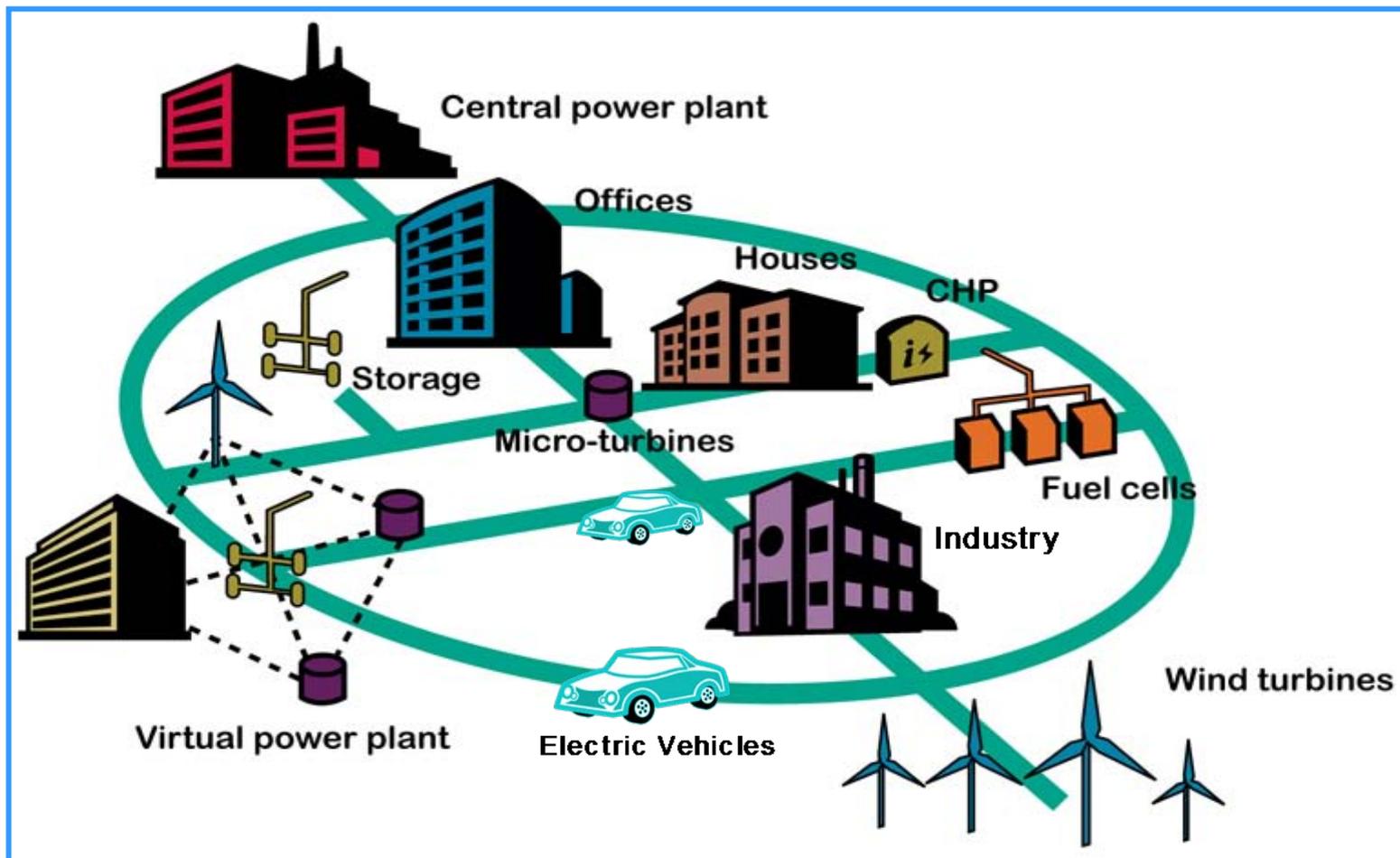
ESB STRATEGIC FRAMEWORK 2020

- **World Class Sustainable Networks**
- **A Renewable Business Of Scale**
- **Best Practice Generation Portfolio**
- **Customer Focused Supply Business**
- **Significant International Business**

Net Carbon Neutral By 2035
Leader In Energy Efficiency



Networks Will Be The Enabler



Smarter Accessible Flexible Efficient

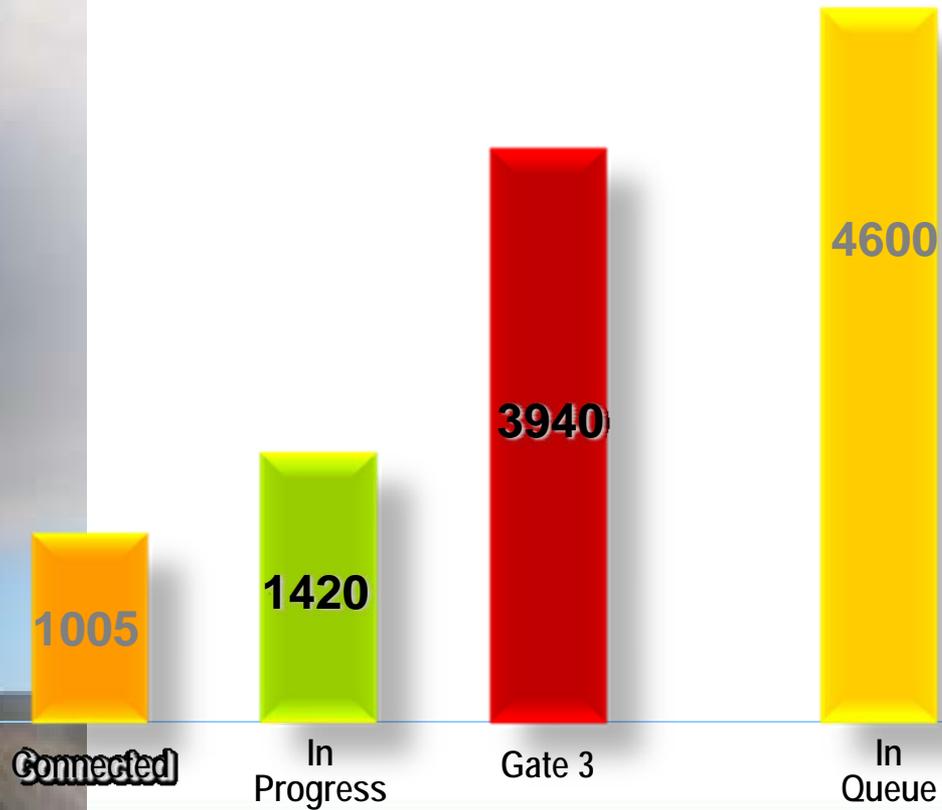


Networks



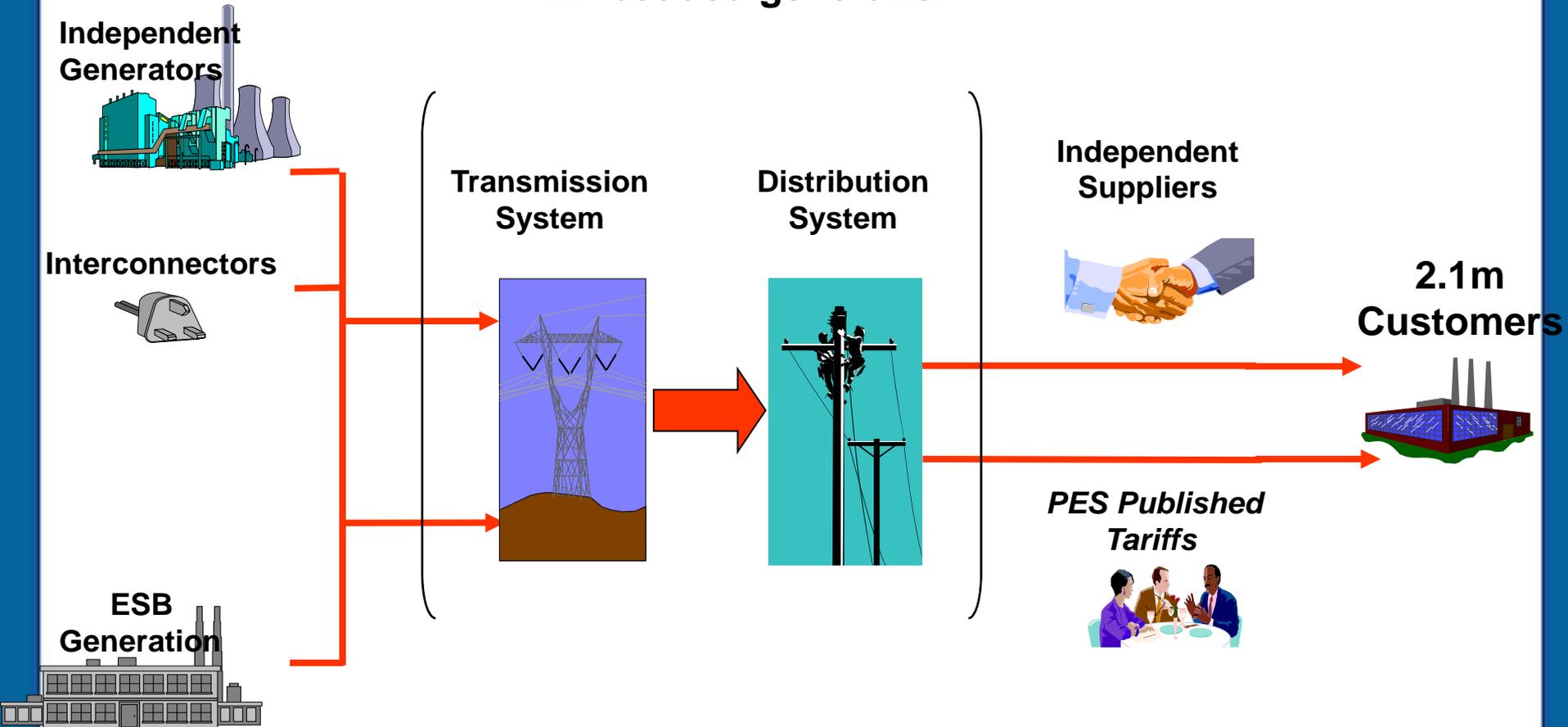
Wind Connections

Q1 2009

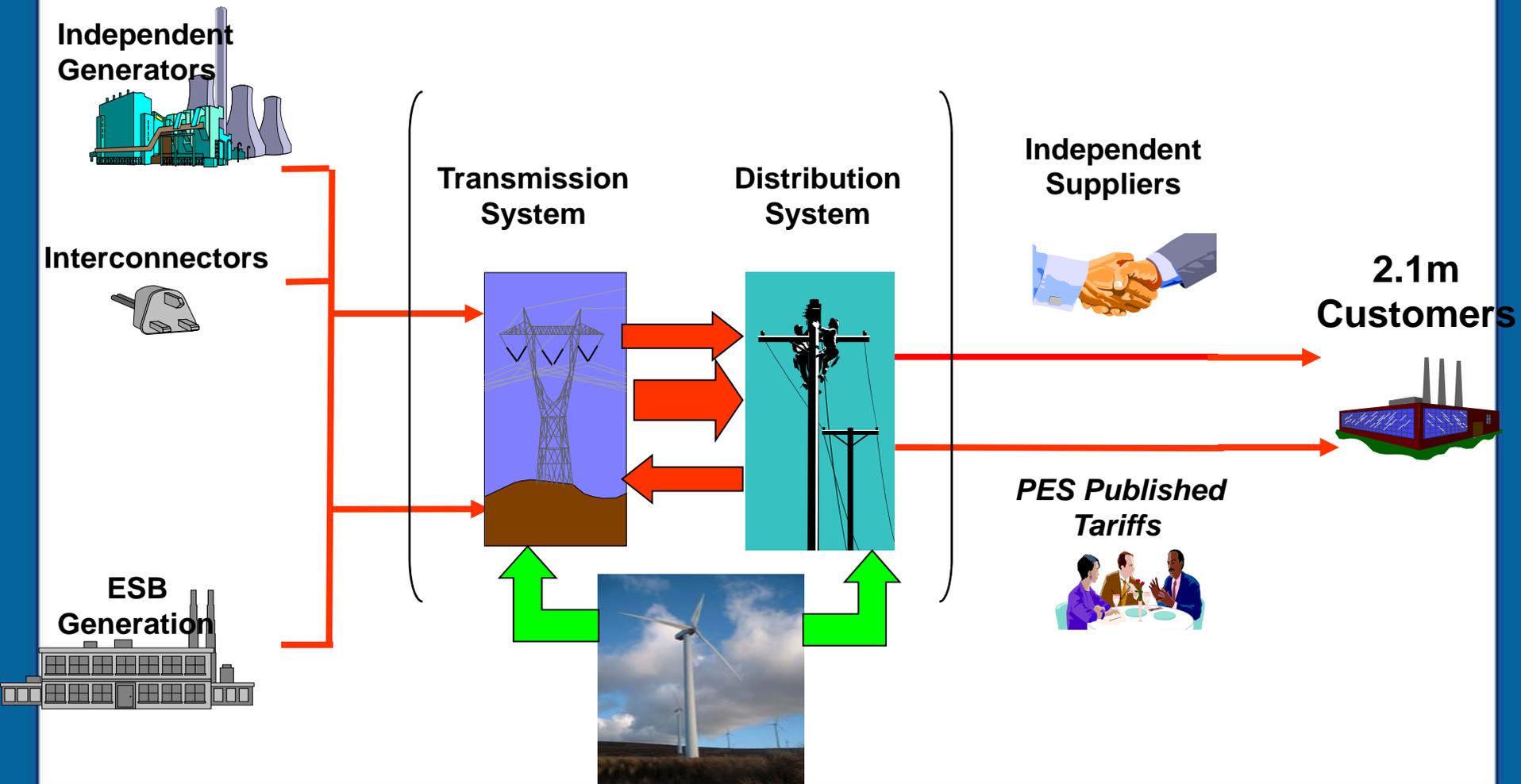


Smart Networks

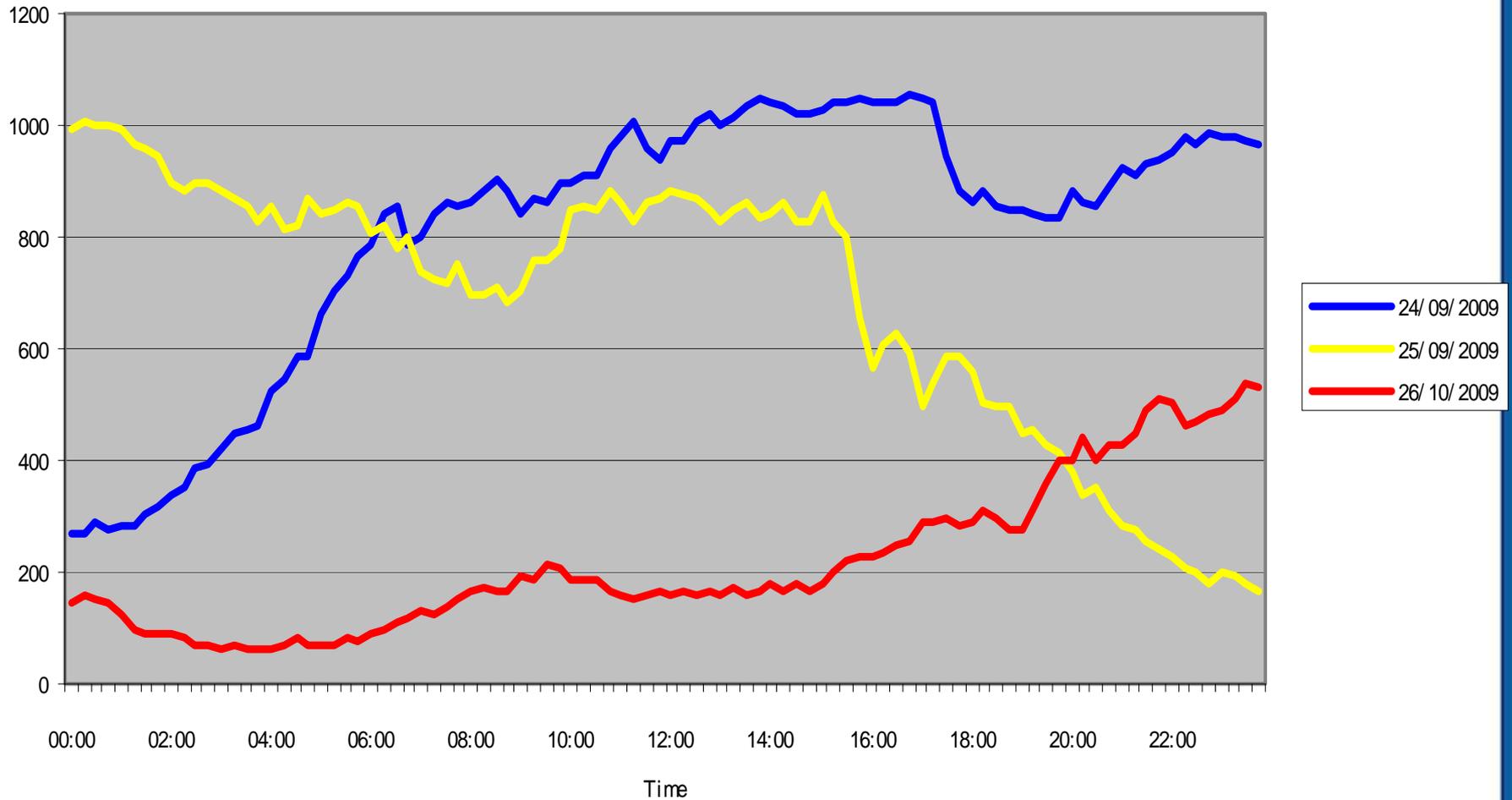
Embedded generation



Direction of Power Flow

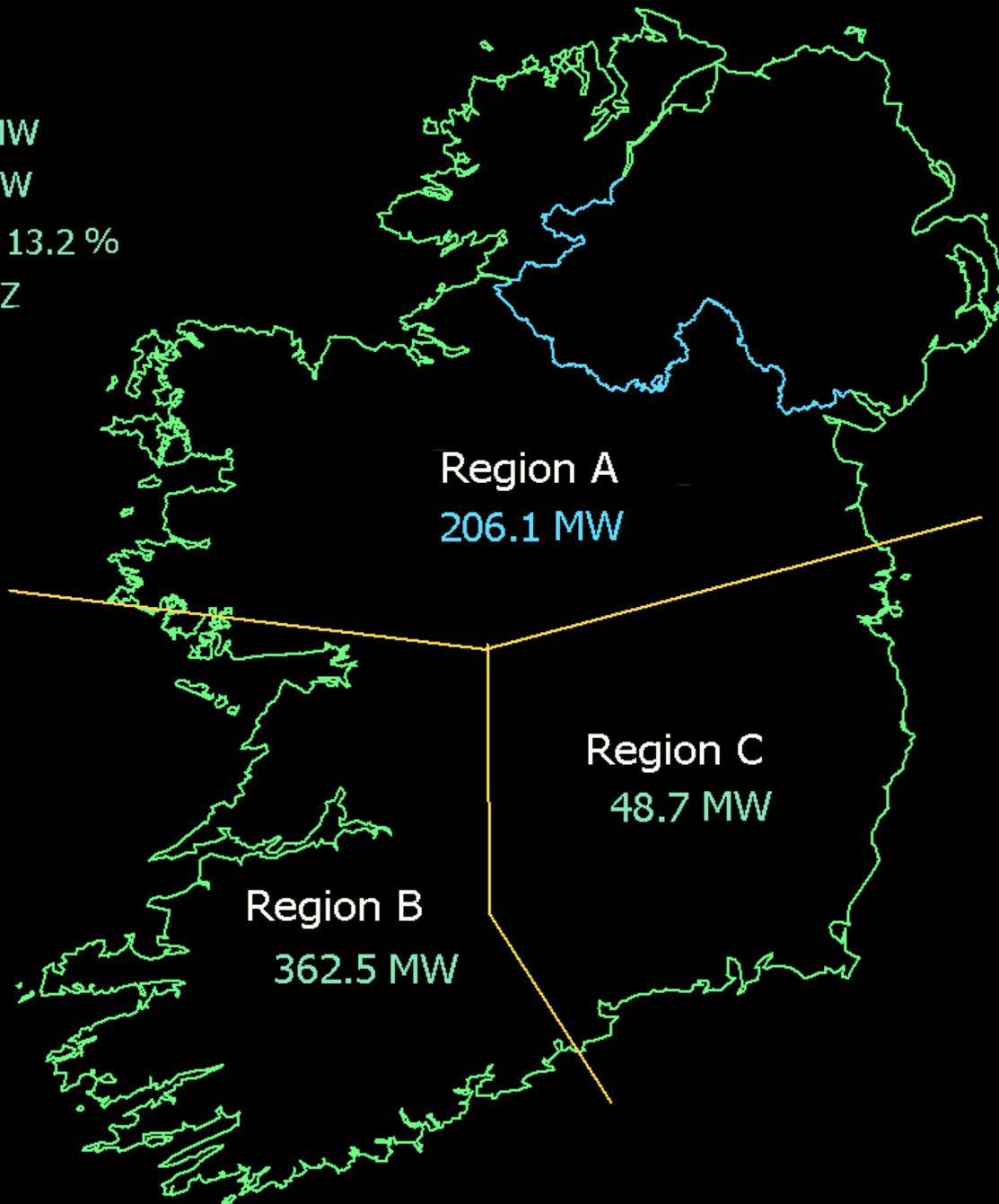


Wind generation profile



Wind Generation

Max System Demand	4664 MW
Total Wind Generation	617 MW
Wind as % of System Demand	13.2 %
System Frequency	50.01 HZ

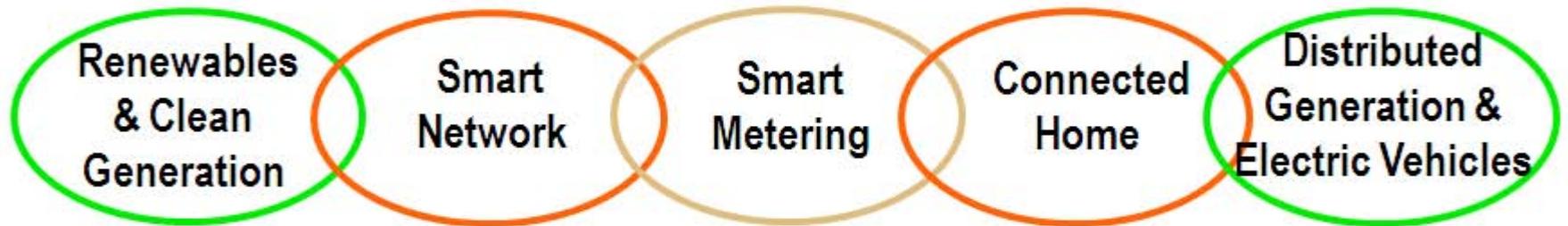


Evolving Smart Networks Model

Energy flow



Information flow



Electricity Infrastructure



IT / Telecom Infrastructure



System management	System managers		
Management System	Distribution Management System		
Distribution Control Centres	Operations & Dispatch		
Operation Systems	SCADA	OMS	
Telecommunications	Data acquisition & communications RTU's, Poling Radio, SatCom, copper		
Communication protocols	Protocol IEC870-5-101, IEC870-5-104, Conitel, PacNet		
Network devices	Substations 	Network devices 	Generation 

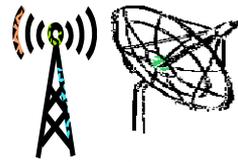
Distribution Management System

- Optimal network configuration
- Short term generation and load forecasting
- Power flow analysis
- Protection performance
- Voltage control
- Direct generation and load control
- Automated network algorithms and control
- Day ahead operational planning
- Network simulation
- Training module

SCADA



Alarm reset
CB open/close
Tapchanges
Relays



Alarms
Circuit breaker status
Amps, kV, MW

SCADA Computers &
Distribution Control Centre



Request for
station attendance

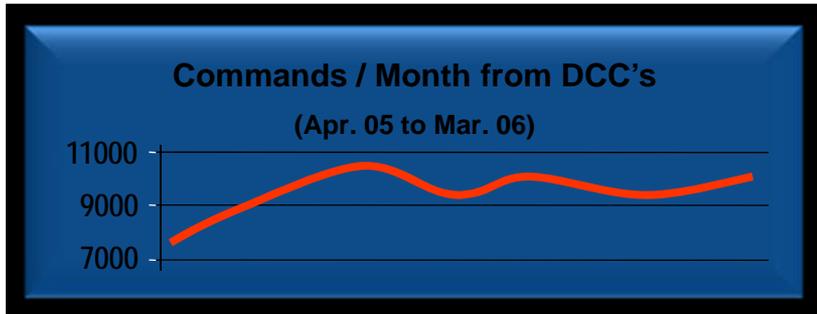
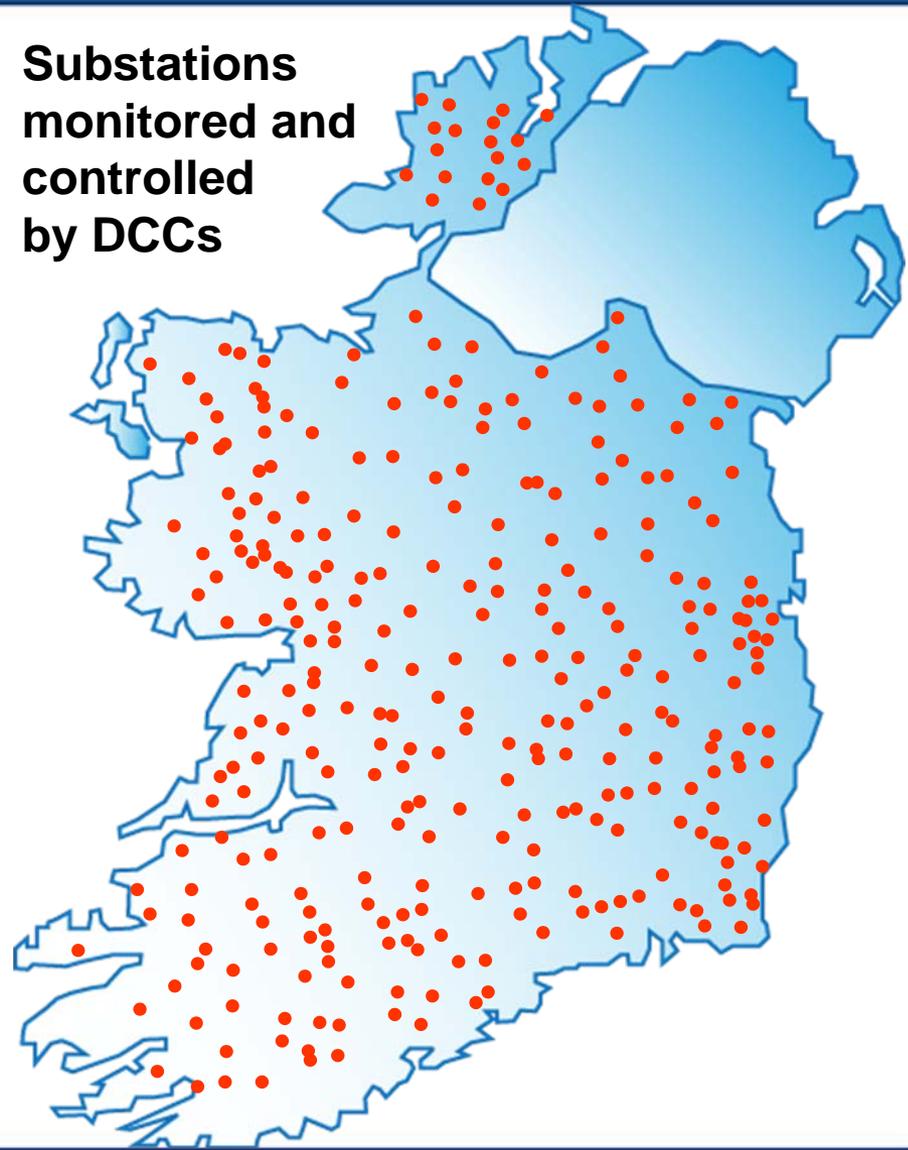
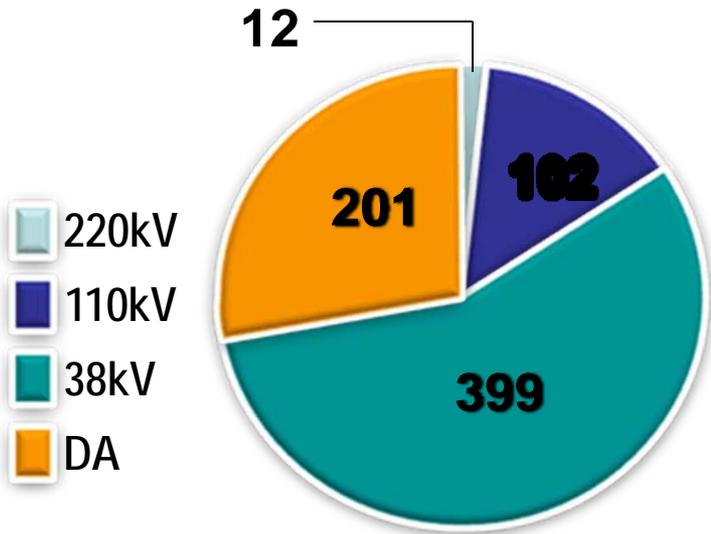
Dispatch



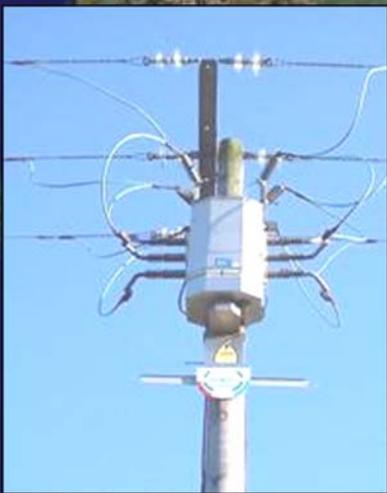
Station visit / repair
NT callout



Substations monitored and controlled by DCCs



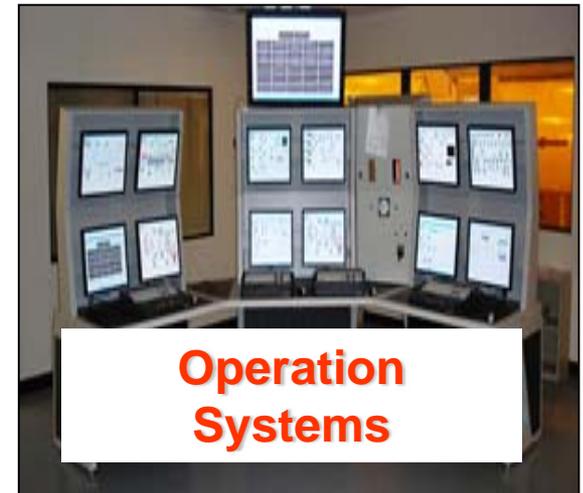
- GPRS DEVICES 
- GSM DEVICES 
- Non-SCADA 

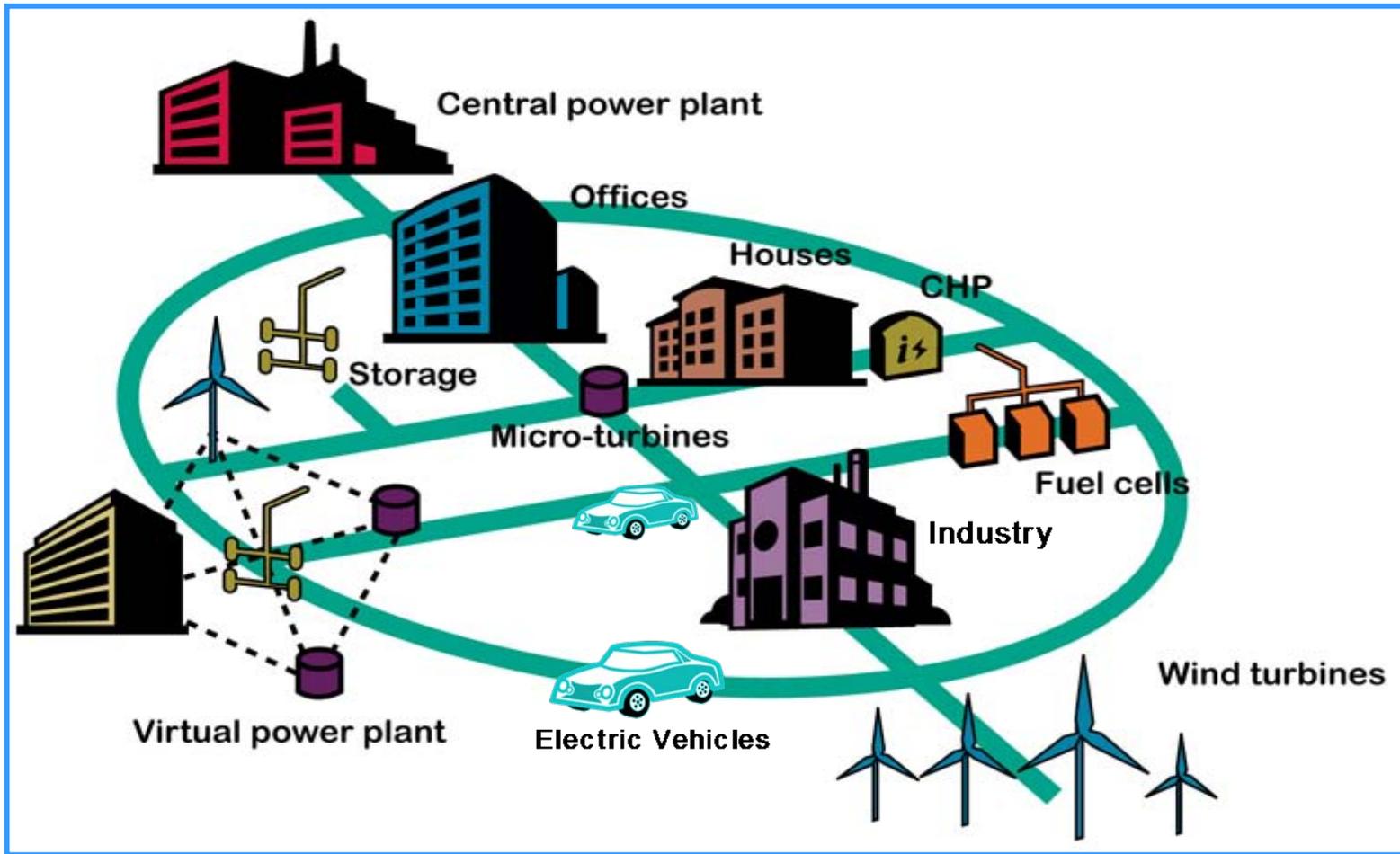


Distribution Automation

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Key Enablers System Management





Smarter Accessible Flexible Efficient



Networks

Customer Perspective

