



Robert Gordon University



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EPSRC

Engineering and Physical Sciences
Research Council

Research to reduce the risk & uncertainty in marine energy development

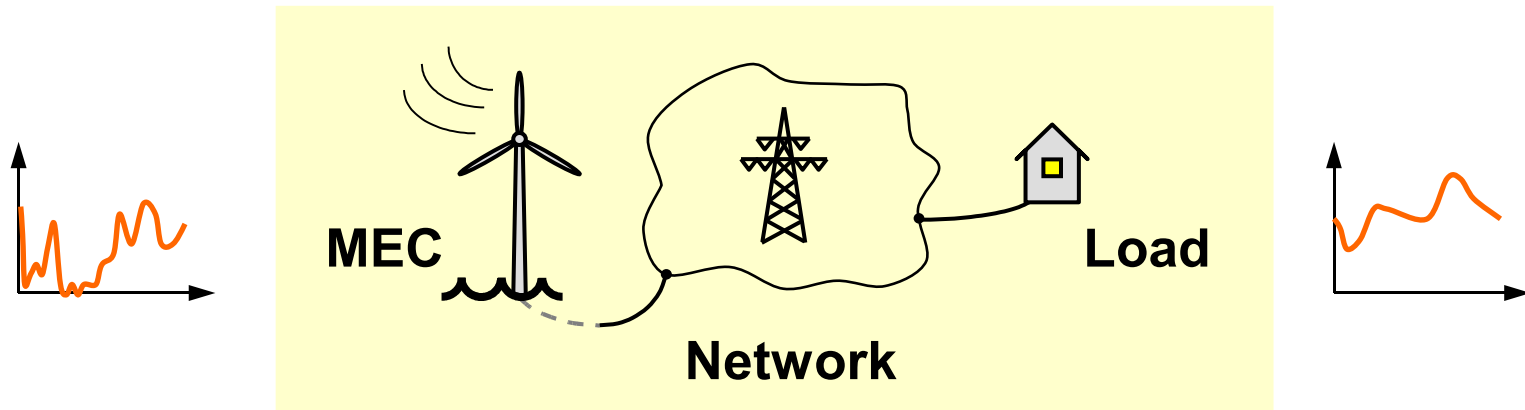
Network Interaction of Marine Energy

Thomas Boehme

Institute for Energy Systems

The University of Edinburgh

The Challenge



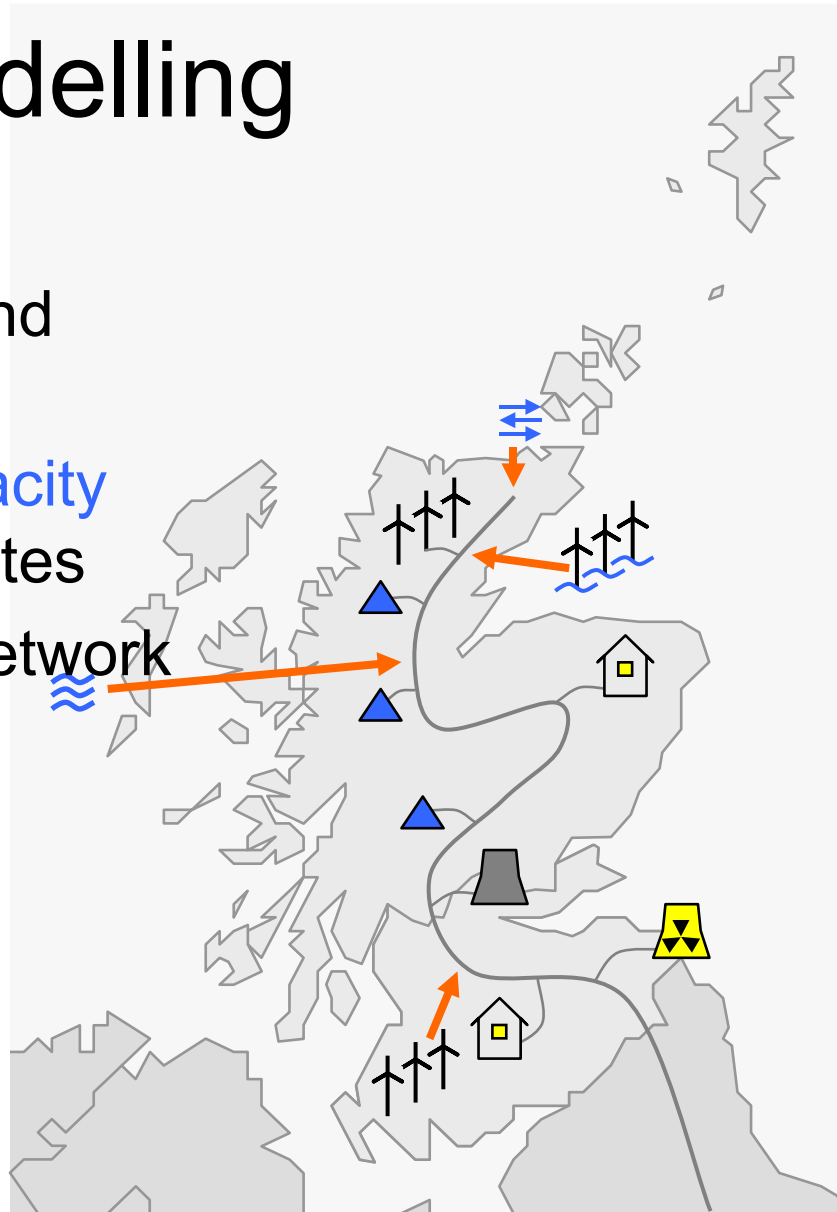
- Marine energy converters will **interact** with the electricity network.
- **Impact** on supply quality needs to be quantified.
- **Mitigation** measures have to be identified.

Objectives

- Modelling of the onshore **electricity network** and offshore extensions.
- Examining **power flow** and voltage profiles and exploring means of **mitigation**.
- Studying the synergies and conflicts from co-location of marine devices with **wind projects**.

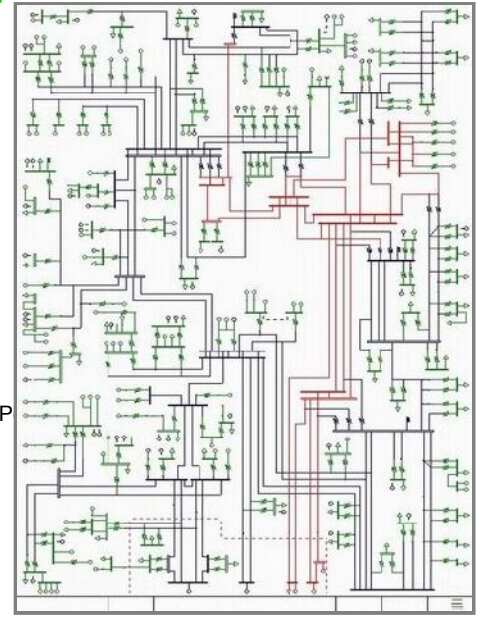
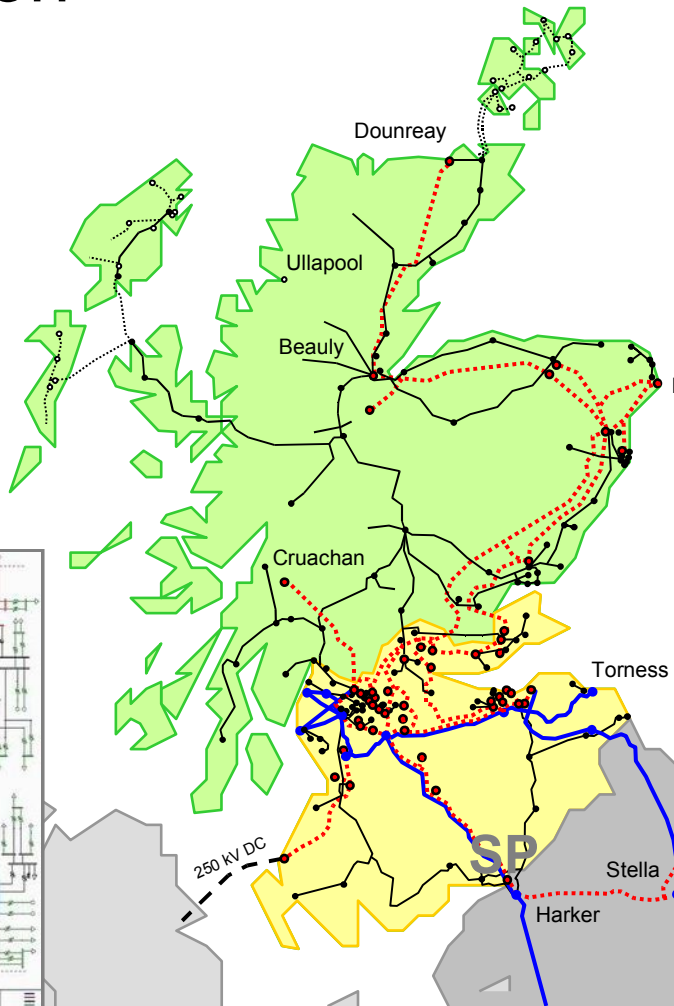
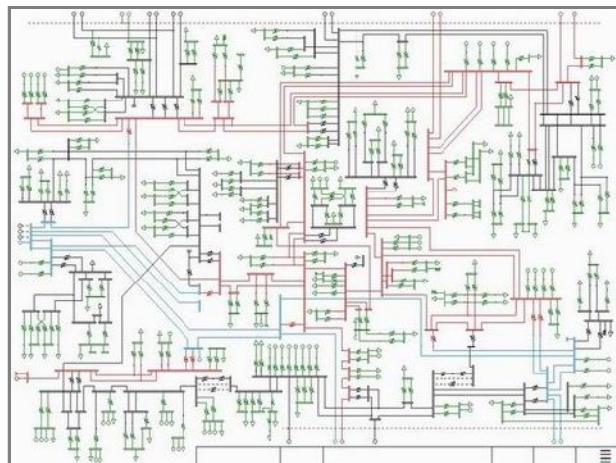
Network Modelling

- Generally **weak network** in Scotland
- Limited **spur transmission capacity** near renewable sites
- **Competition** for network access



Network Modelling

- Transmission network simulation
- Inter-regional power flows



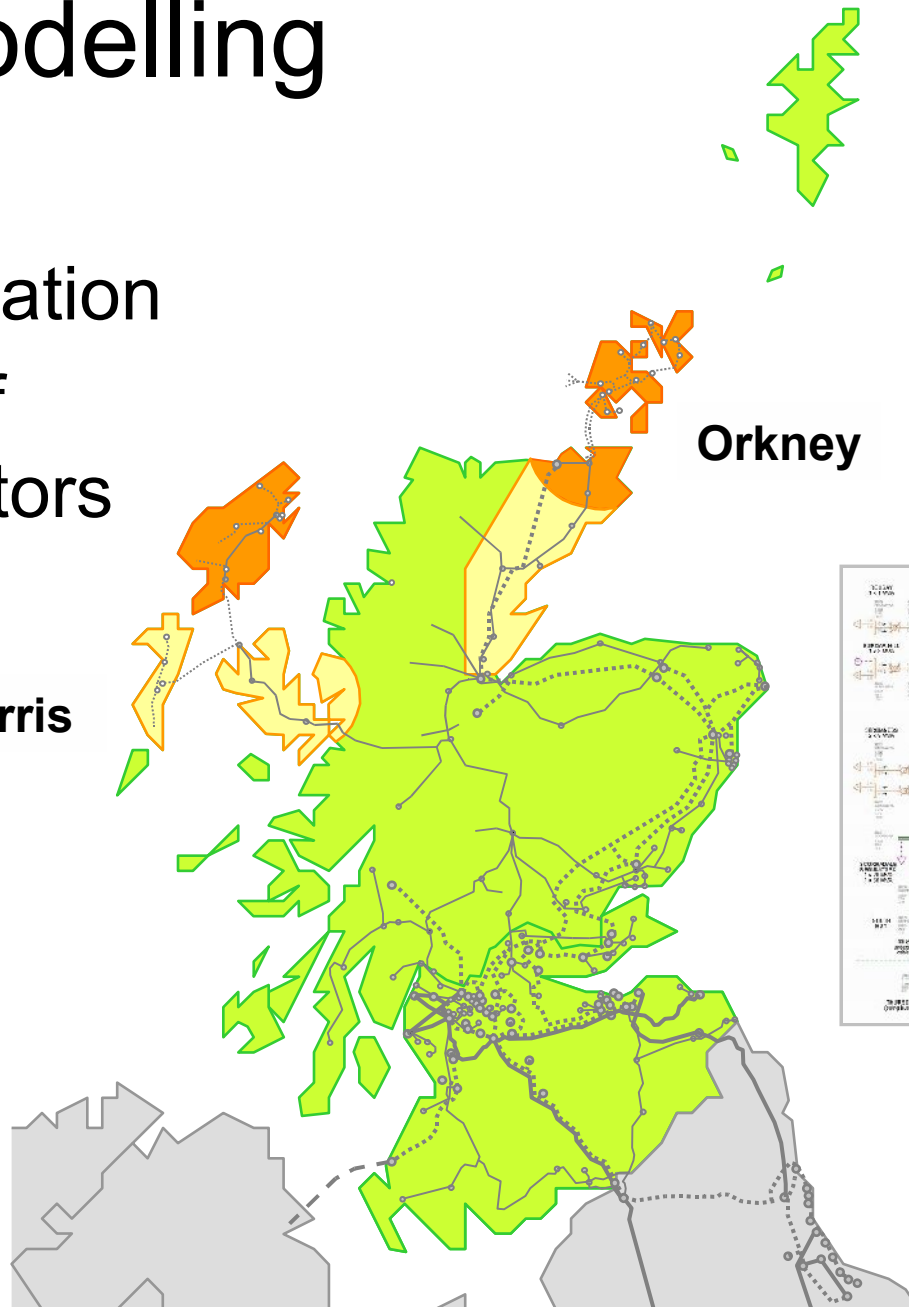
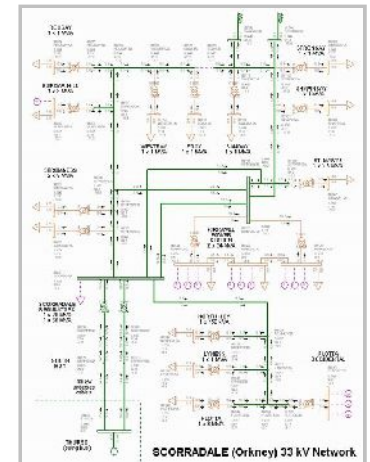
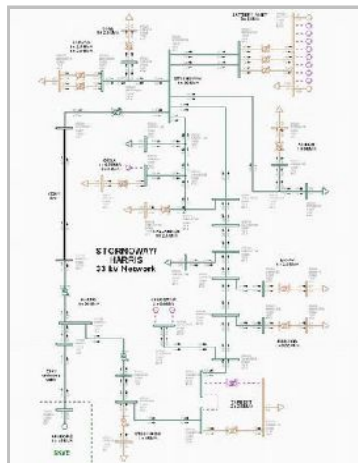
Network Modelling

- Distribution network simulation
- Connection of future generators



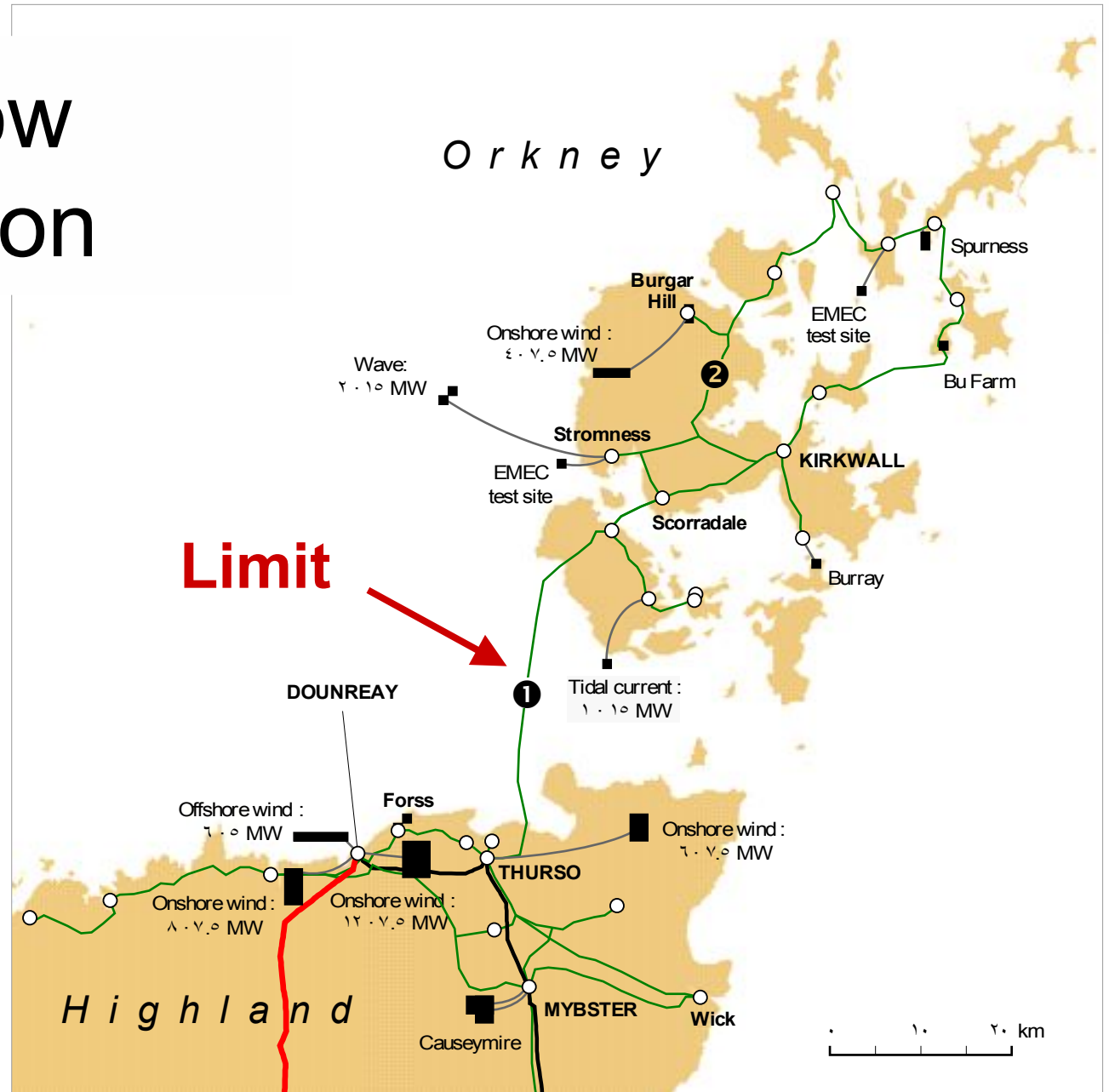
Lewis, Harris

Orkney

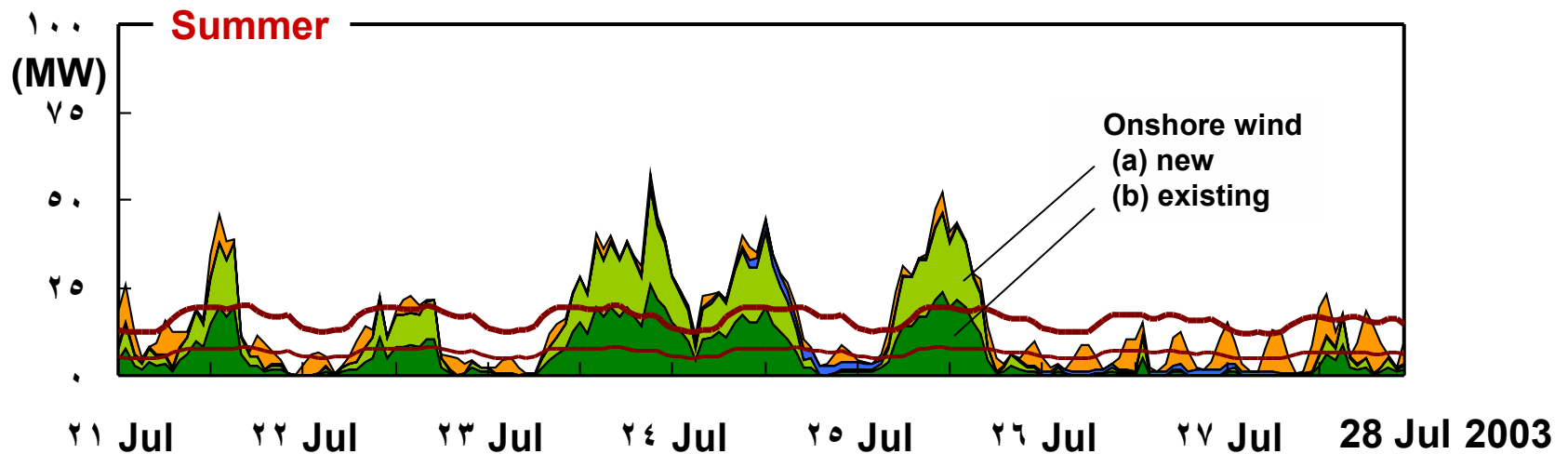
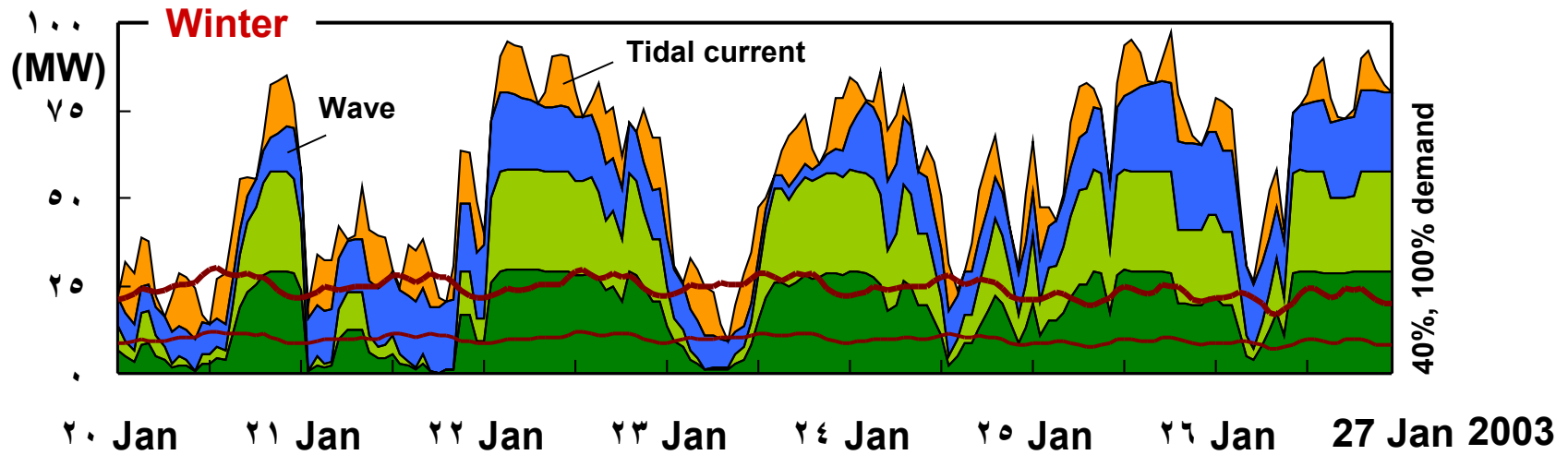


Power Flow Examination

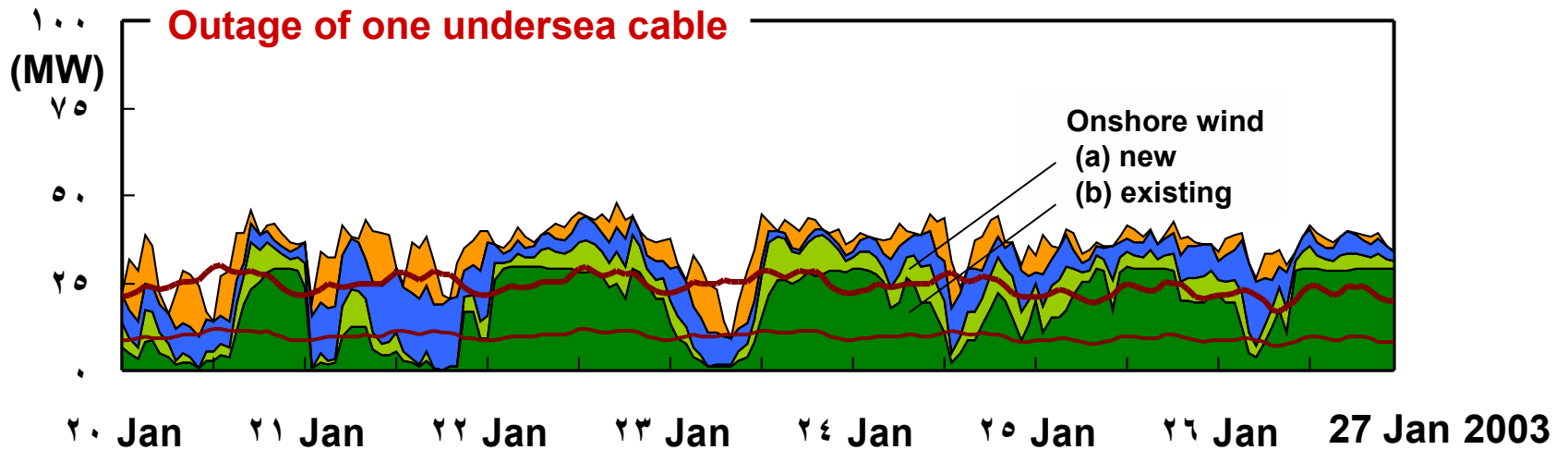
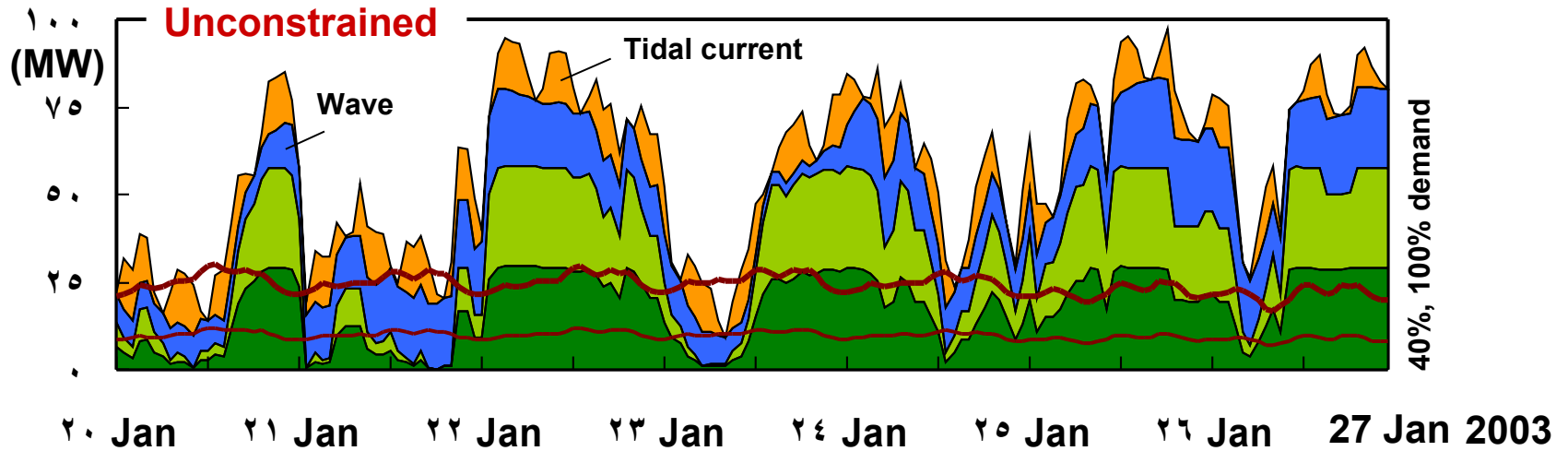
- Existing and new **generation** mapped.
- **Time series** of power (hourly) applied.



Orkney with existing & new generation Demand Matching

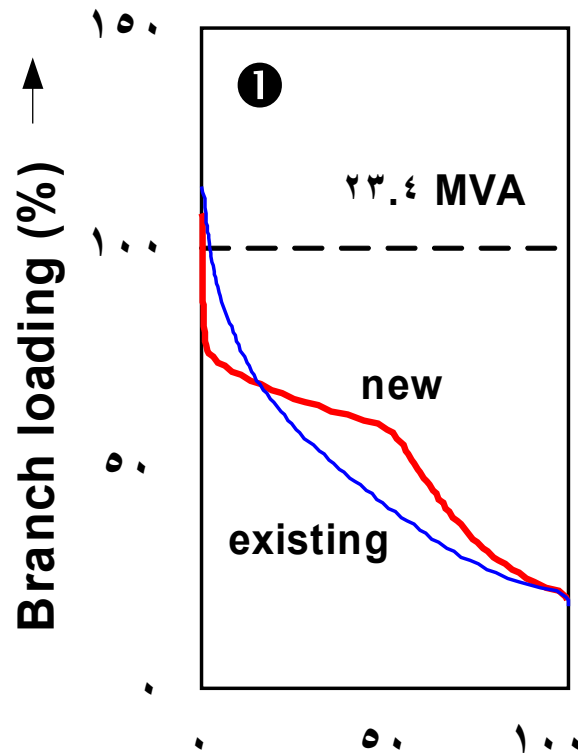


Orkney with existing & new generation Demand Matching

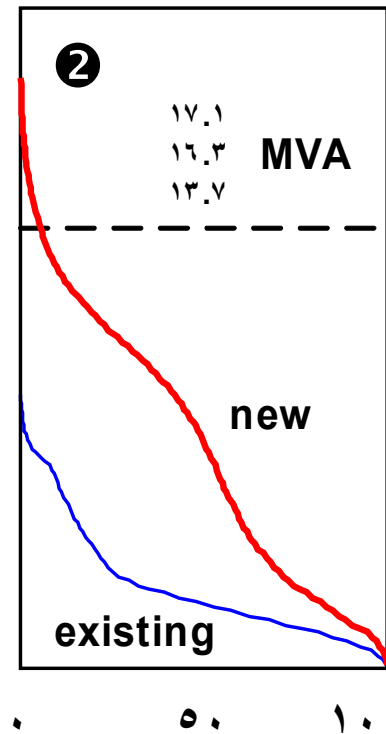


Case Study - Branch Loading

**Orkney – Mainland
undersea cable**



**Selected overhead
line**



Significance

- Applying **time series in power flow simulations** identifies
 - Line, cable and transformer **loading**
 - Voltage level **ranges**
 - Reactor and transformer tap changer **usage**
 - Generator output **limitation** by network operator
 - Required diesel **backup**.
- Method is useful for
 - improved **asset management** and
 - to specify network **connection agreements**.

Further work

- Application of **Optimum Power Flow** to keep power system parameters within limits.
- Test on **large networks**, possibly with a nested approach.