



University of
Strathclyde
Engineering






Application of Demand Side Control Functions on Active Network Management

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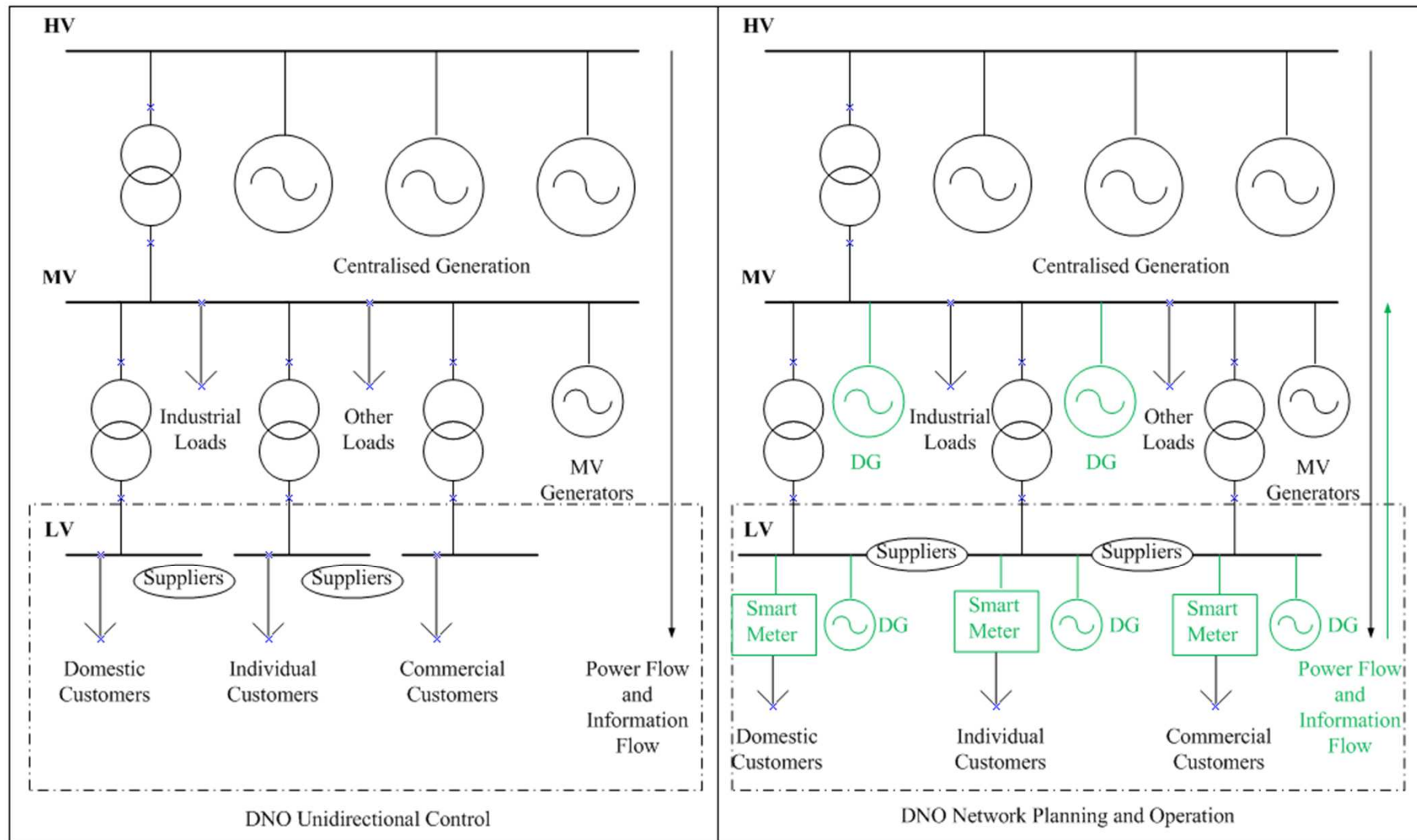
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Network Structure

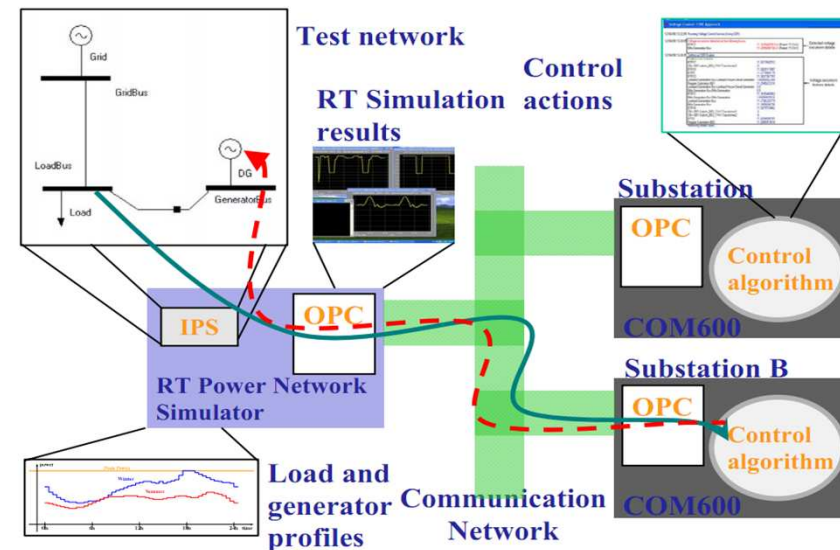


Active Network Management

- Real time control (V, P, I_F)
- Optimize distributed and renewable generation
- Capacity reinforcement deferral
- Network constraint management
- Flexibility and extensibility



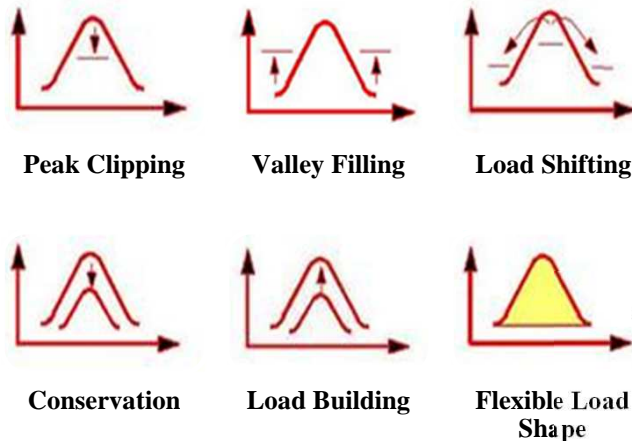
AuRA-NMS
(Autonomous Regional Active
Network Management)



Plug and Play

- Steady state voltage control
- Automatic restoration
- Power flow management (CSP)
- Network optimization strategies
- Demand Side Management (DSM)

Demand Side Management



Main Functions:

- Distribution planning, monitoring, and implementation
- Customer behaviour influence
- Demand and supply balancing
- Improvement of demand response and energy efficiency

Main Opportunities (CUE):

- Better deals for customers
 - Manage household loading
 - Avoid network overloading and network reinforcement (Local/ Global)
 - Balance variable generation at the regional/national level
 - Balance the positions for energy suppliers
 - Reduce the need for new build of large power plants
- [Ref: Smart Grids UK Perspectives, ena]

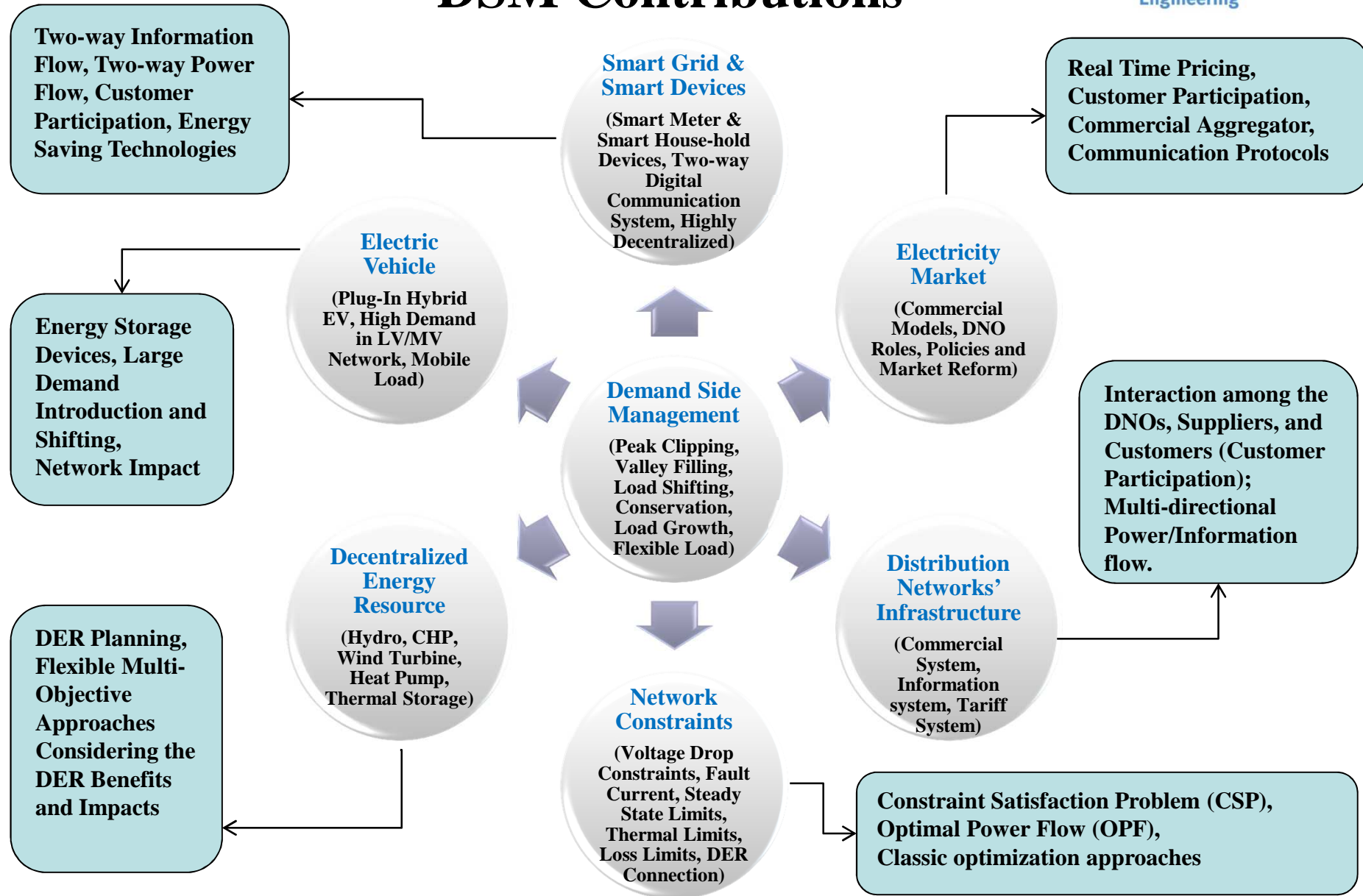


Main Drivers:

- 20-20-20 Targets (EU)
- Emission Trading Scheme
- Renewable Heat Incentives
- Low Carbon Policy
- Smart Grid Construction

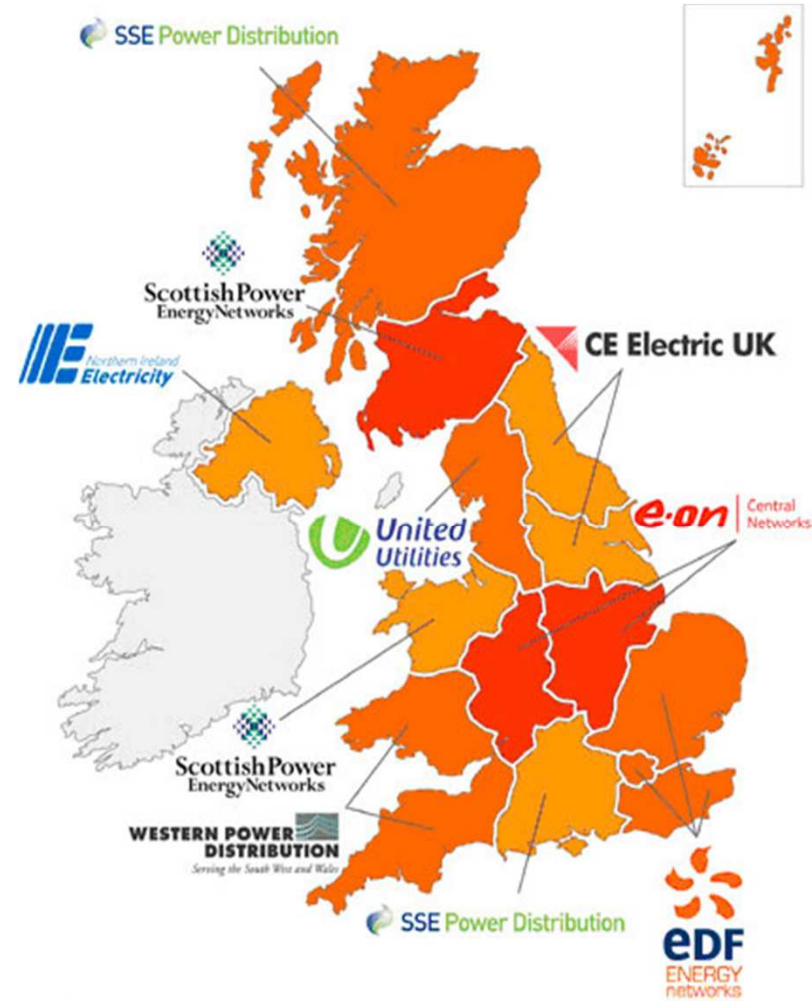
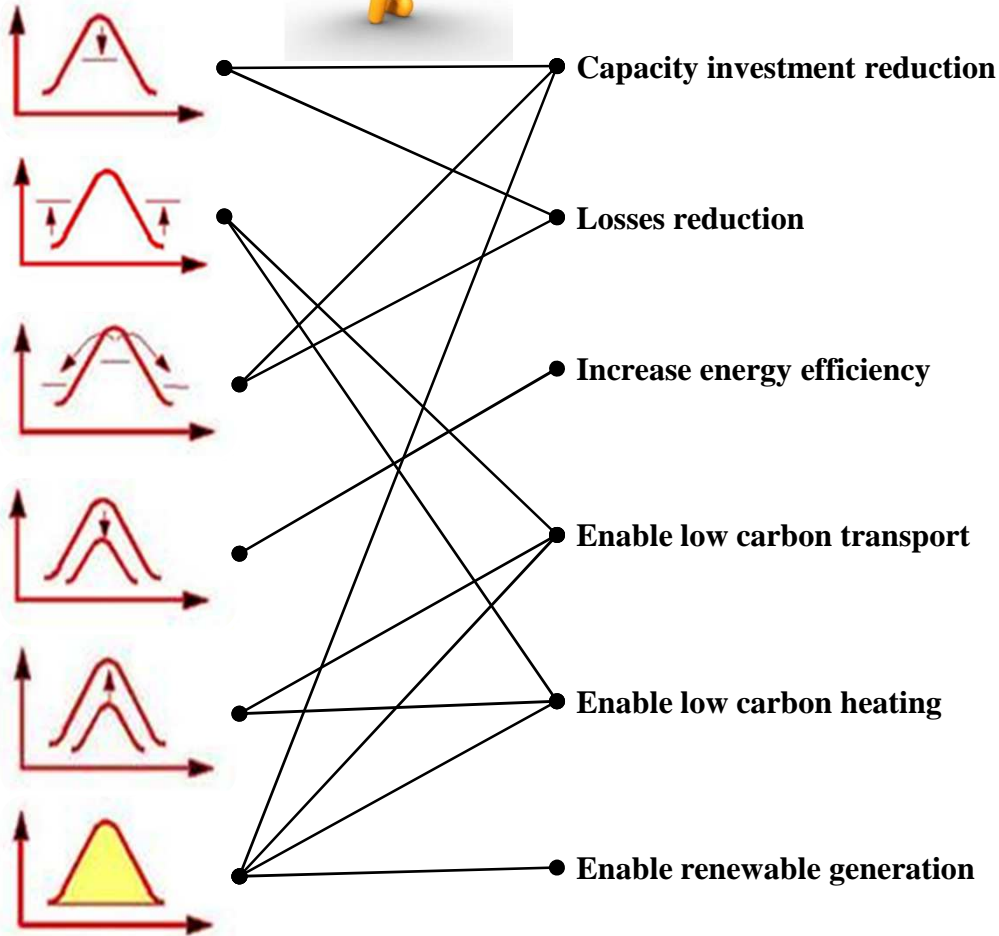


DSM Contributions





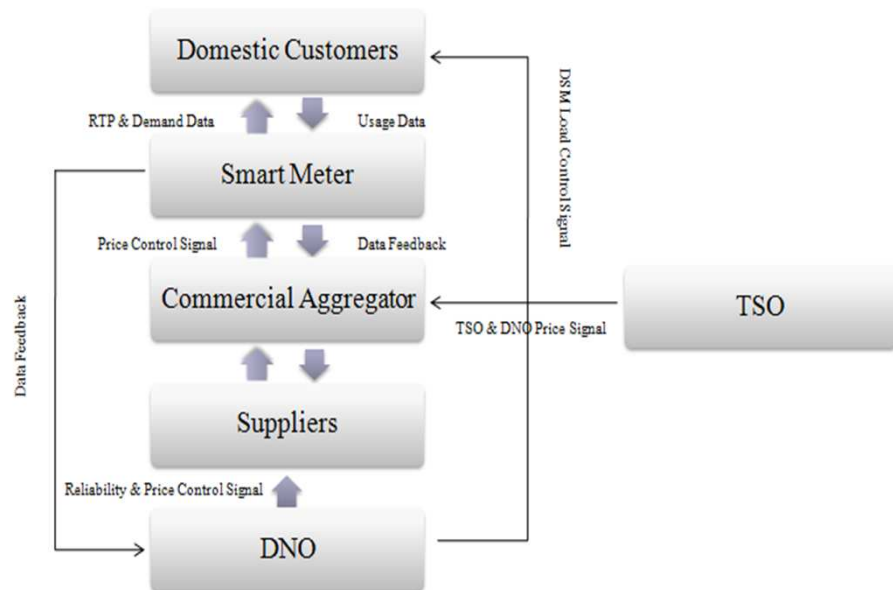
DNO Perspectives



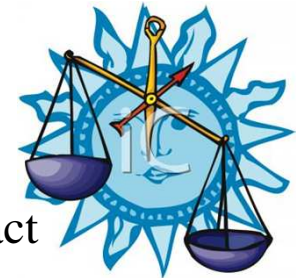
Models and Planning

- Commercial Model (DNO Roles)
 - Time-of-Use Tariff Scheme
 - Real Time Pricing Scheme
 - Maximum Demand Scheme
 - Supplier Business Scheme
 - DNO Directly Control Scheme

- Developing Plan
 - Setting Objectives
 - Identifying Alternatives
 - Evaluation and Selection
 - Implementation
 - Monitoring



- Marketing Planning
 - Customer Education
 - Direct Customer Contact
 - Trade Ally Cooperation
 - Advertising and Promotion
 - Alternative Pricing
 - Direct Incentives

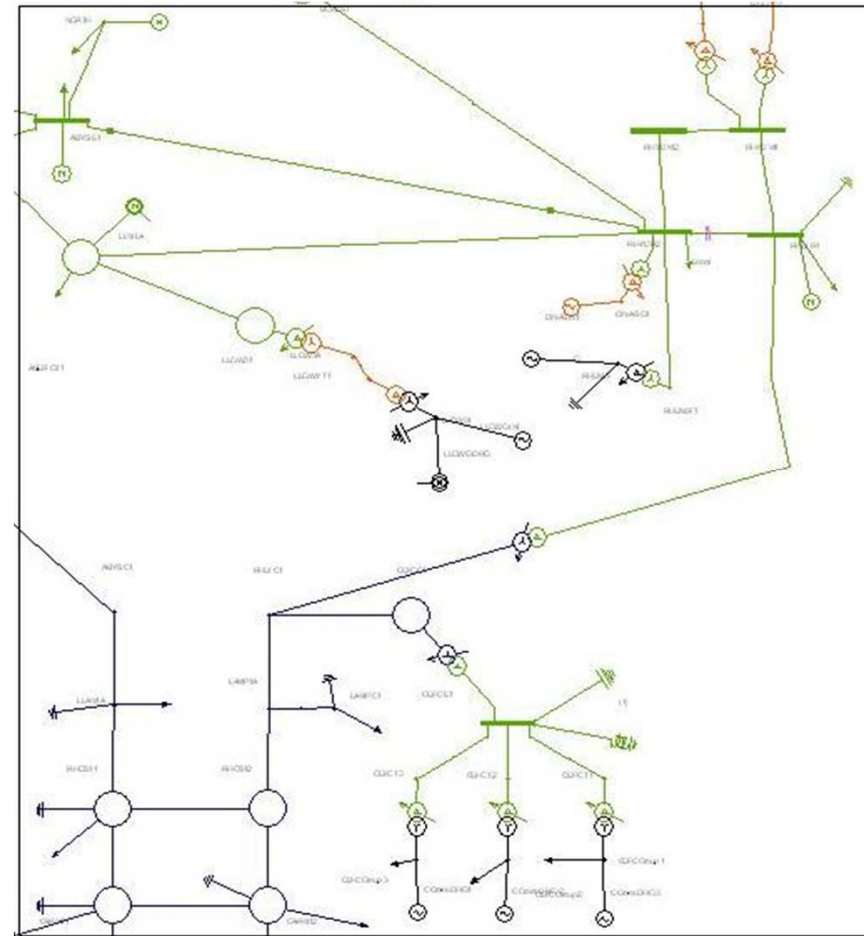


Constraints Satisfaction Problem

- Network Constraints
 - Thermal Constraints
 - Transformer Capacity
 - Short Circuit Level
 - Short Circuit Ratio
 - Voltage Rise/Drop
 - Distributed Energy Resources

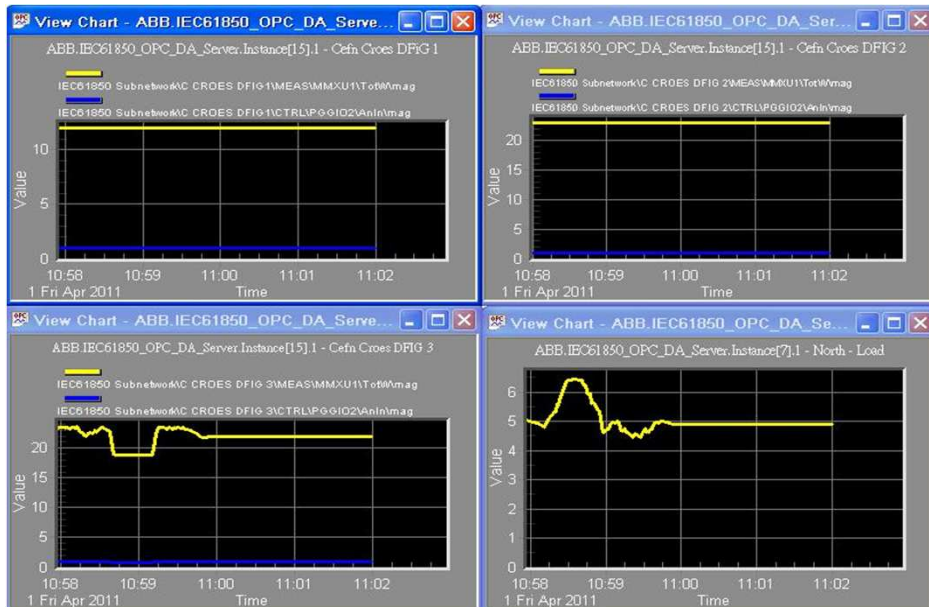
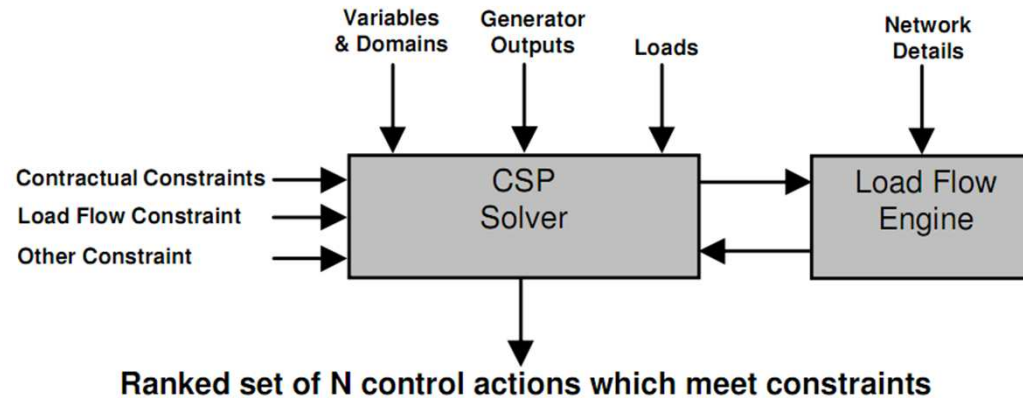
- CSP for network overload
 - DG connection (LIFO)
 - Demand side control (priority based)

- Simulation for DG Curtailment
(Michael's Model in IPSA)



33kV Network Model for High DG and High Load Simulation

CSP for DG Control



04/01/11 10:58:25: Overloads detected on the following circuits:
RHYD R2 - ABYS E1: 17.5007278062 MVA (Rated: 17.4 MVA)

04/01/11 10:58:37: The following measures are being applied:

```
LLGW51.LLWGW DF10: Generator can run unconstrained (4.44MW)
CEFC Group 2.C Croes DF10 2: Generator can run unconstrained (23.5MW)
CEFC Group 3.C Croes DF10 1: Generator can run unconstrained (12.0MW)
DINAS G1.DINAS G1: Generator can run unconstrained (3.0MW)
LLGW51.LLWGW IM: Generator can run unconstrained (5.1MW)
RHEI G2.RHEI G2: Generator can run unconstrained (20.0MW)
CEFC Group 1.C Croes DF10 3: Generator should be constrained to max output of 18.8MW (80.0%)
MYNN A.MYNN G IM: Generator can run unconstrained (10.4MW)
RHEIWE.G: Generator can run unconstrained (2.4MW)
RHEI G3.RHEI G3: Generator can run unconstrained (20.0MW)
Time taken to compute solution using CSP: 10.6854679336
```

Number of load flows run: 11

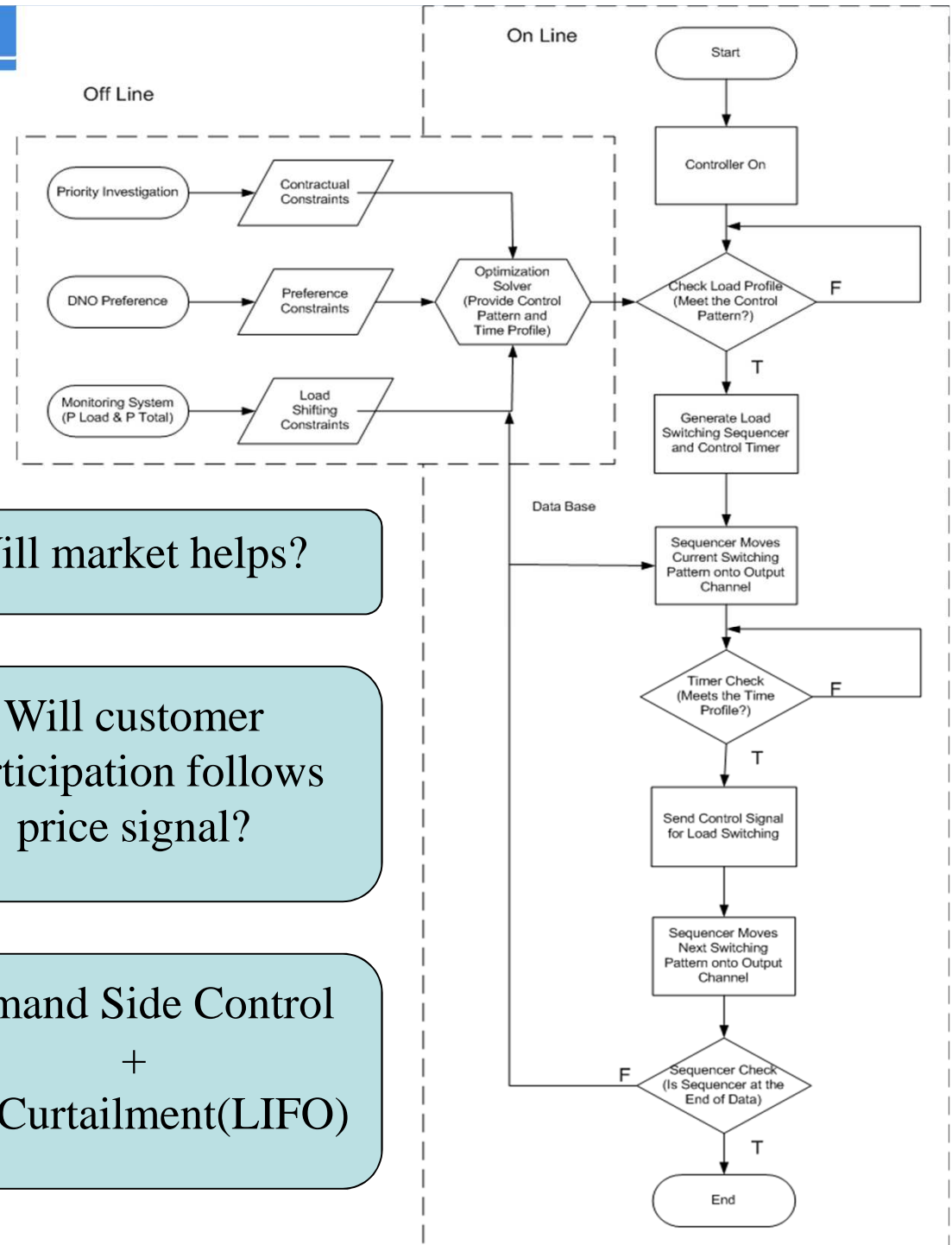
04/01/11 10:58:49: Overloads no longer detected

04/01/11 10:59:10: Network loading is such that constraints on generation can be removed
The following measures are being applied:

```
LLGW51.LLWGW DF10: Generator can run unconstrained (4.44MW)
CEFC Group 2.C Croes DF10 2: Generator can run unconstrained (23.5MW)
CEFC Group 3.C Croes DF10 1: Generator can run unconstrained (12.0MW)
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```

Demand Side Control Flow Chart

- DSM Solver:
 - Off line ‘Control’
 - On Line Control
- Constraints:
 - Contractual (Priority)
 - DNO Preference
 - Power Flow
- Inputs:
 - Variables
 - Demand Forecasts
 - DG Accesses
- Outputs:
 - Control Patterns
 - Data History



Will market helps?

Will customer participation follows price signal?

Demand Side Control + DG Curtailment(LIFO)

Conclusion and Future Work

- Demand side management application
- DNO perspective of DSM functions
- Commercial models and Network planning
- Active network management and control approaches
- Demand side control: load control vs. DG control
- DSM control functions (online/offline control)
- Demand side control algorithm (CSP for thermal limits)
- Optimization capability for the planning and operations
- LV network case study and control implementation

