

Reactive Power Delivery Incentives

Harvard Electricity Policy Group 12/2/04

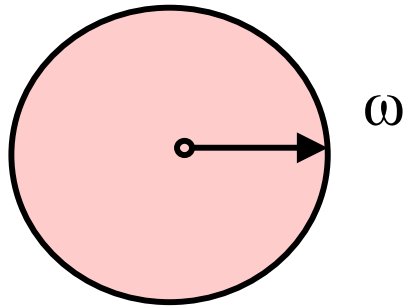
Alan Robb VP Operations GridAmerica LLC

Agenda

- **What is Reactive Power?**
 - Why do we need it?
 - How is it provided?
 - Who can provide it?
 - How do we balance voltage?
- **The UK Reactive supply**
- **New England & New York Reactive payment arrangements**

To the engineer.....

Sinusoidal voltage:

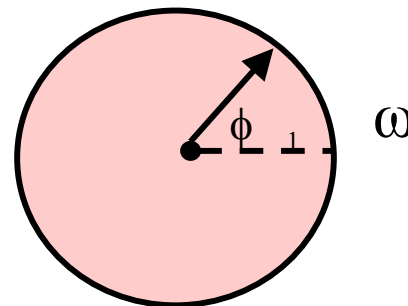
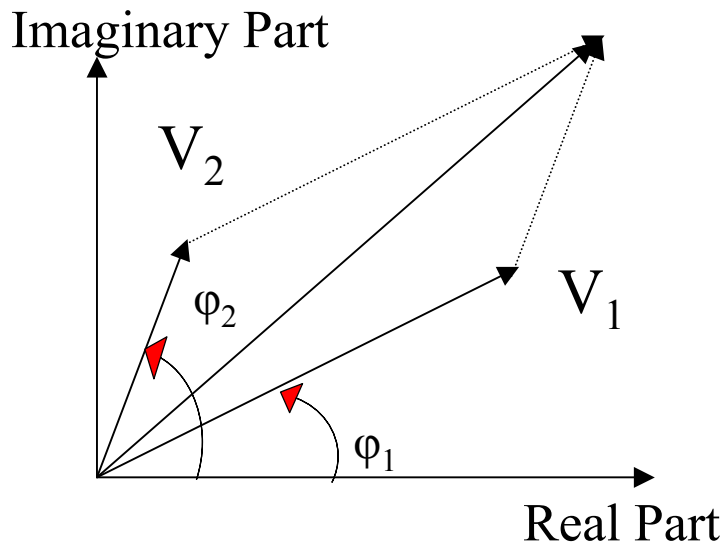


Constant angular velocity: ω

Sinusoidal voltage:

$$V_1 = V_1 \sin(\omega t + \phi_1)$$

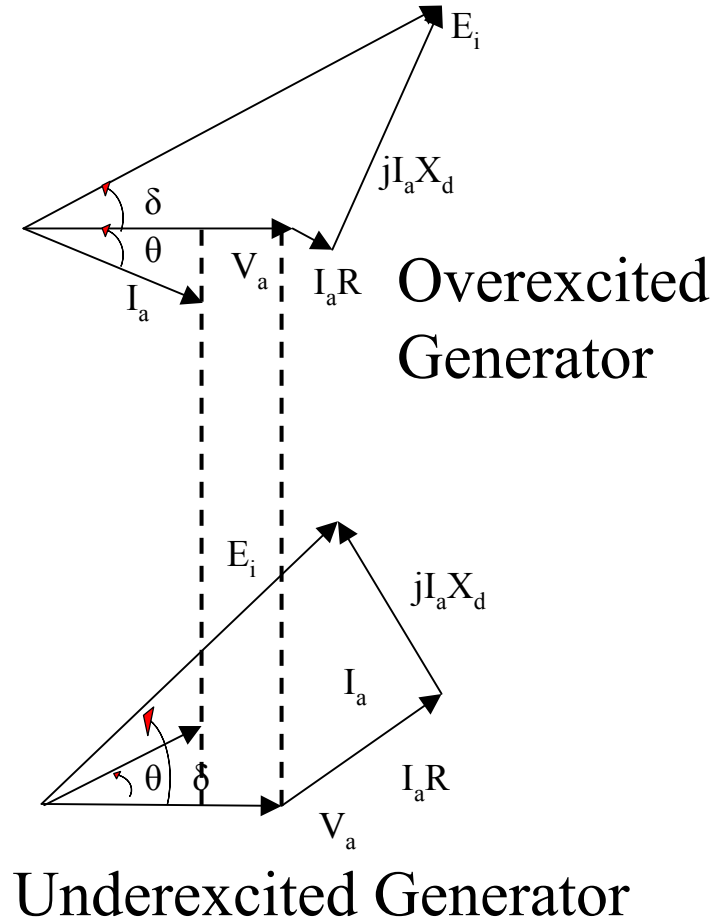
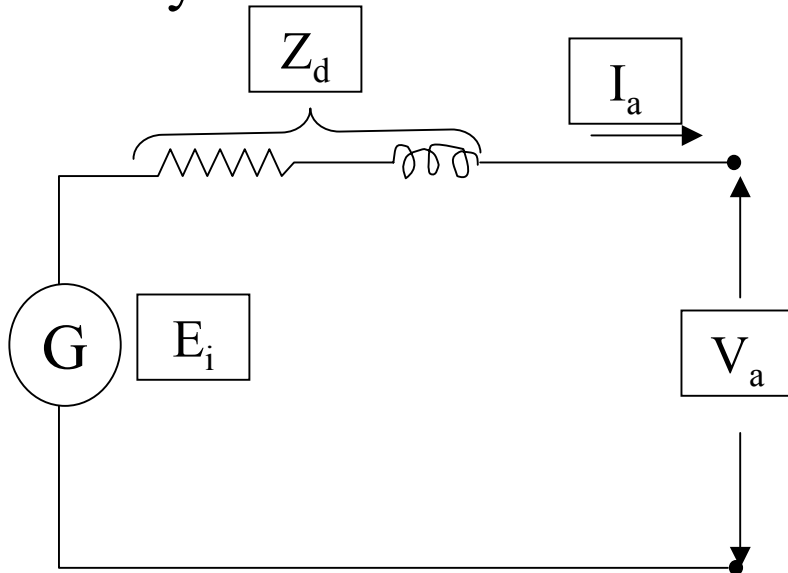
$$V_2 = V_2 \sin(\omega t + \phi_2)$$



↑
Time-Domain
representation

To the engineer.....

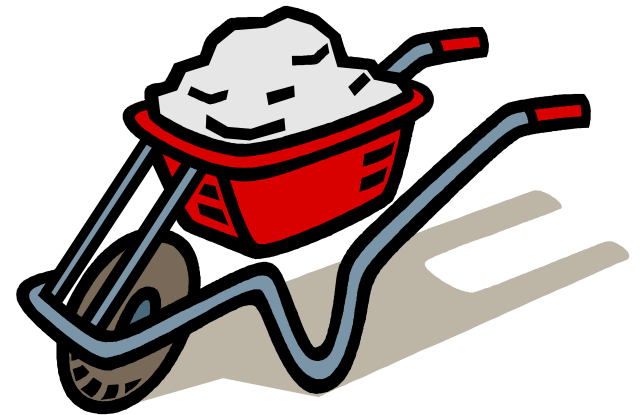
- Synchronous Generator



To the rest of us.....an analogy helps

**You can't move the wheelbarrow
(active power delivery)**

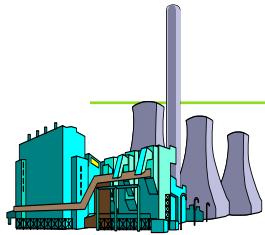
**unless you lift the arms!
(reactive power)**



Why do we need it?

- **maintain system reliability**
 - support local system voltage
 - maintain voltage step changes within specified limits, steady state post fault
- **support the transmission of active power**
- **the requirements vary with location and load**

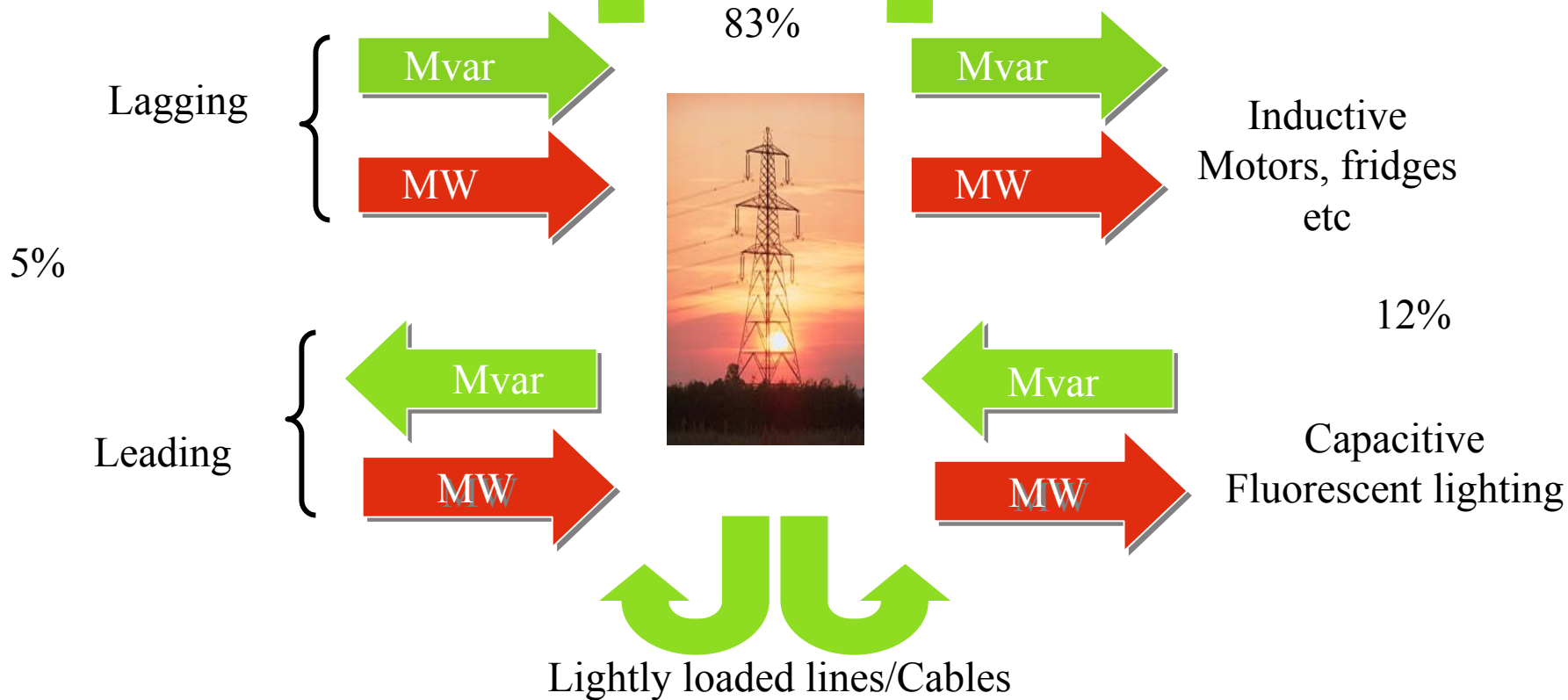
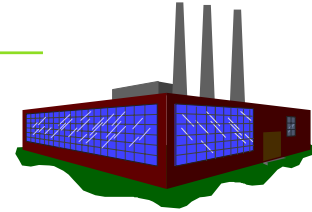
How is it provided?



Generation

Heavily loaded lines

Demand



Who can provide it?

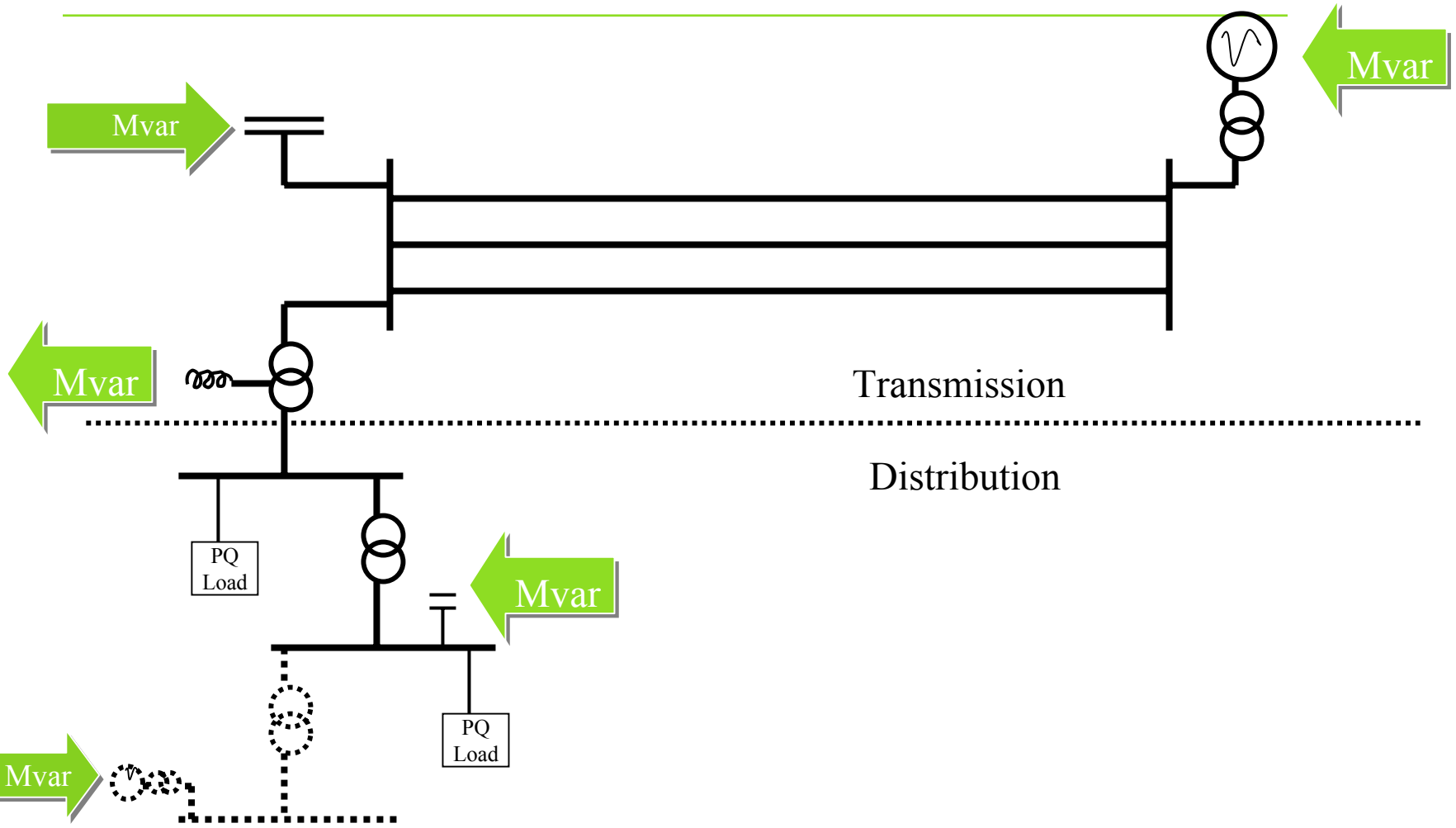
Controllable Sources/Sinks

- **Generators**
- **Synchronous compensators**
- **Capacitive and inductive compensators**

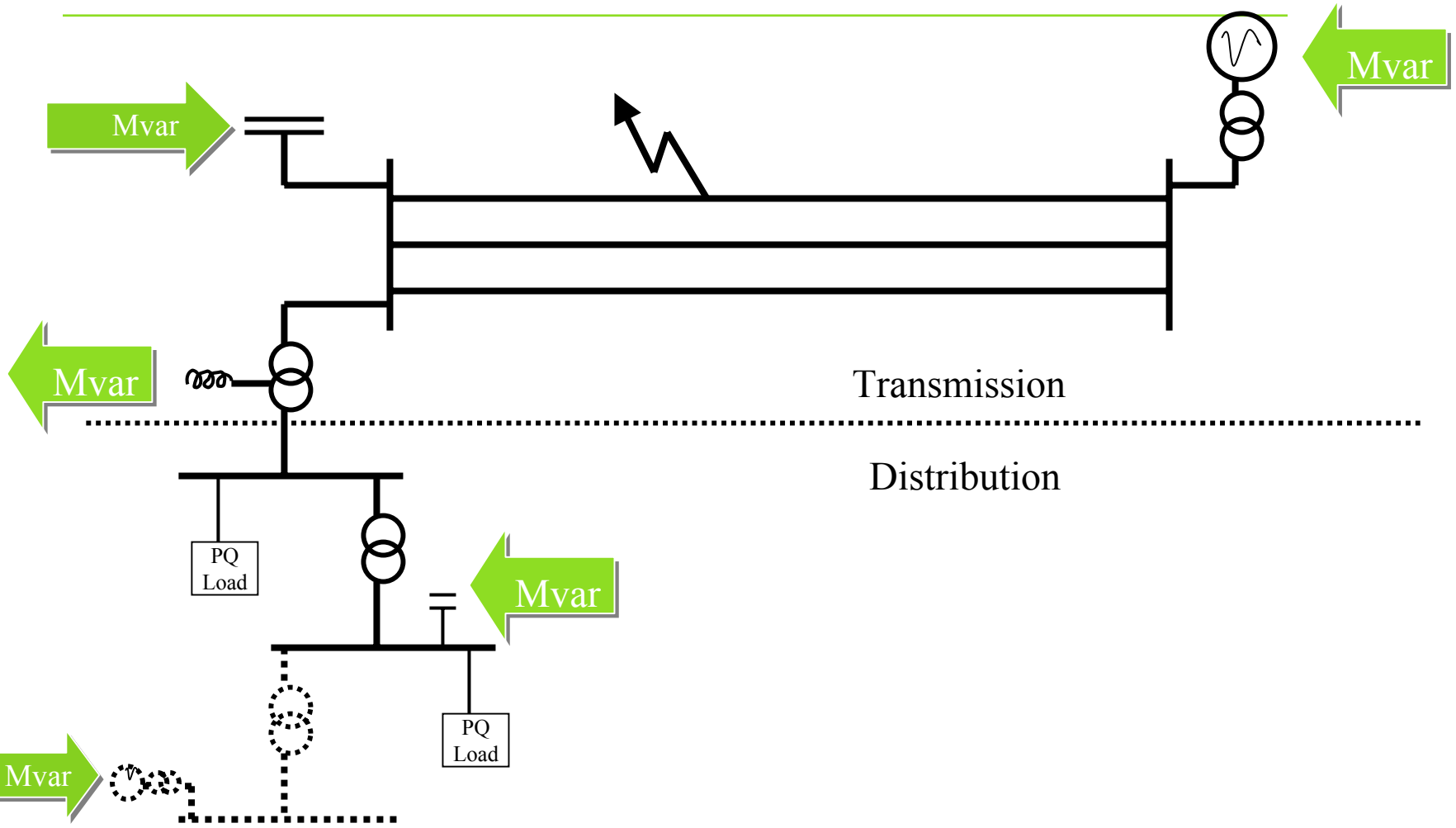
Less Controllable Sources/Sinks

- **Overhead Lines**
- **Underground cables**
- **Transformers**
- **Customer demand**

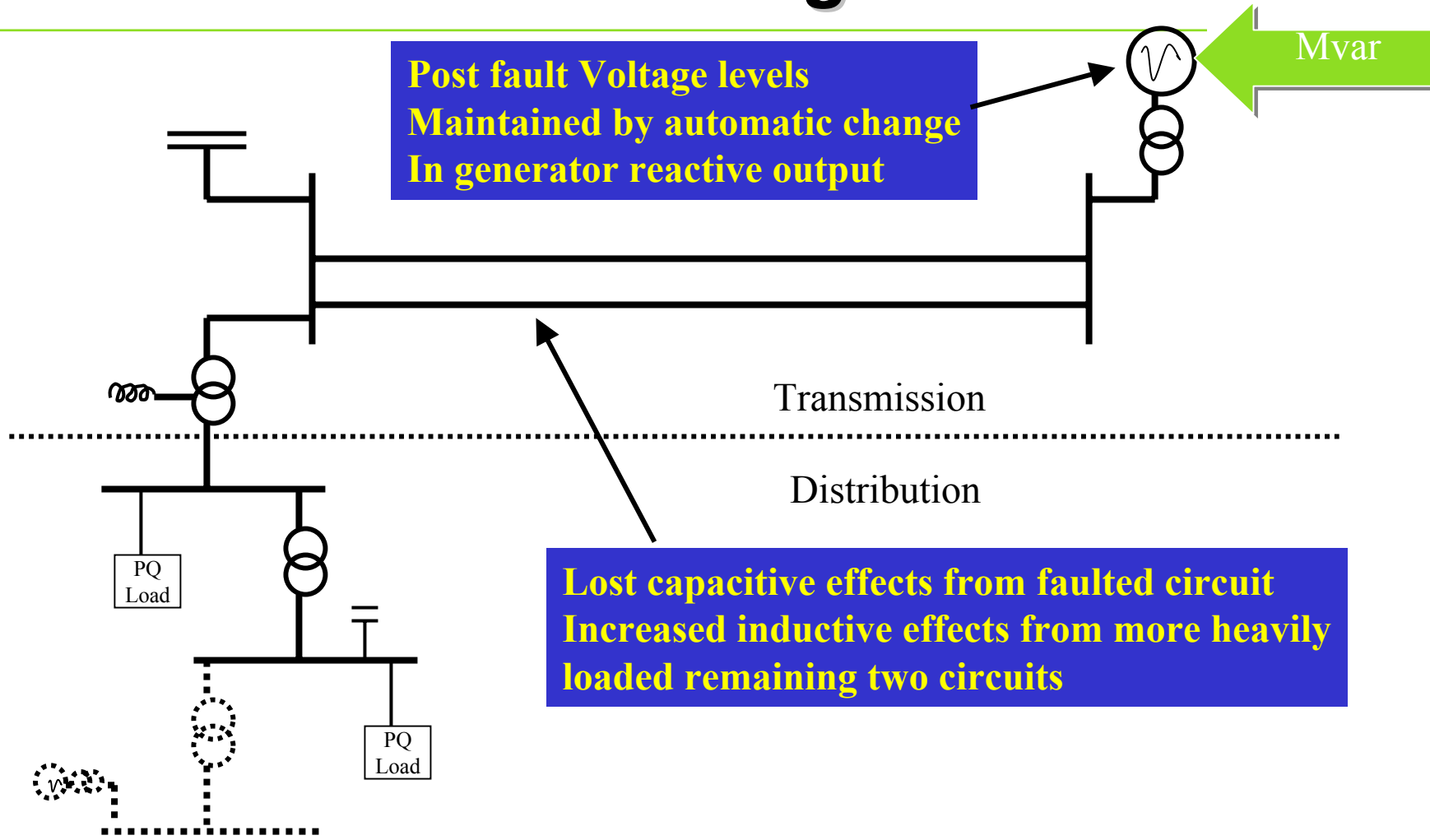
How we balance voltage



How we balance voltage



How we balance voltage



UK Reactive Supply

1997 onwards

- **Obligatory Reactive Power Service (aka the “Default Service”)**
- **Enhanced Reactive Power Service**
- **Both services, especially, enhanced market services, interact with transmission investment and expansion**
- **Under purview of Regulator**
- **Funded by daily payment from suppliers**

Obligatory Reactive Power Service

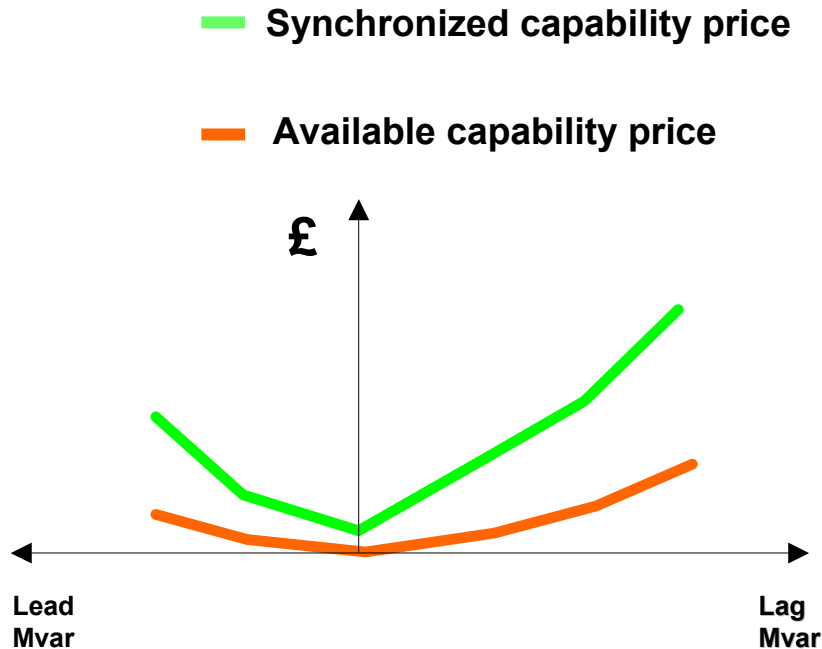
- **Rule based payments (enforced via Grid Code obligation)**
- **Default obligation on all large generators (typically >50MW)**
- **Minimum reactive power range**
- **Fixed MVARh payment rate (reviewed annually)**
 - **Transition to utilization only payment (step down from 80% capability to 0% capability over 4 years)**
 - **Payment is currently approximately \$2.40/MVARh**
- **No need to tender**

Enhanced Reactive Power Services

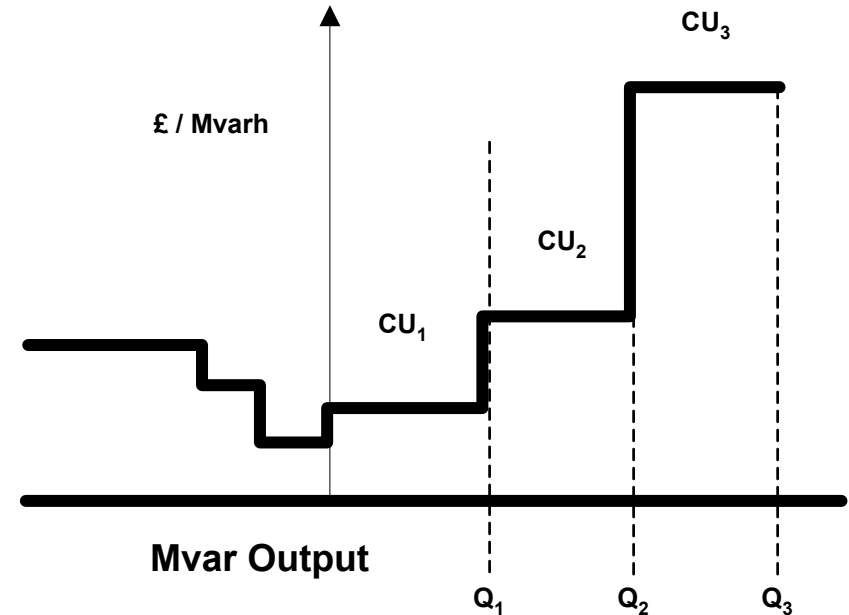
- **Can be same technical service as the “Obligatory RPS”**
- **Offered via market tender**
- **More potential providers (eg. smaller generators)**
- **Minimum 15MVA_r (lead or lag)**
- **Generator offers price curves**
- **Contracts 12 months minimum**
- **Generator chooses prices and other terms to tender**
- **Can offer additional services**
- **If tender not accepted, still gets Obligatory RPS (ie.default rate)**

Reactive Supply – Enhanced Reactive Power Service

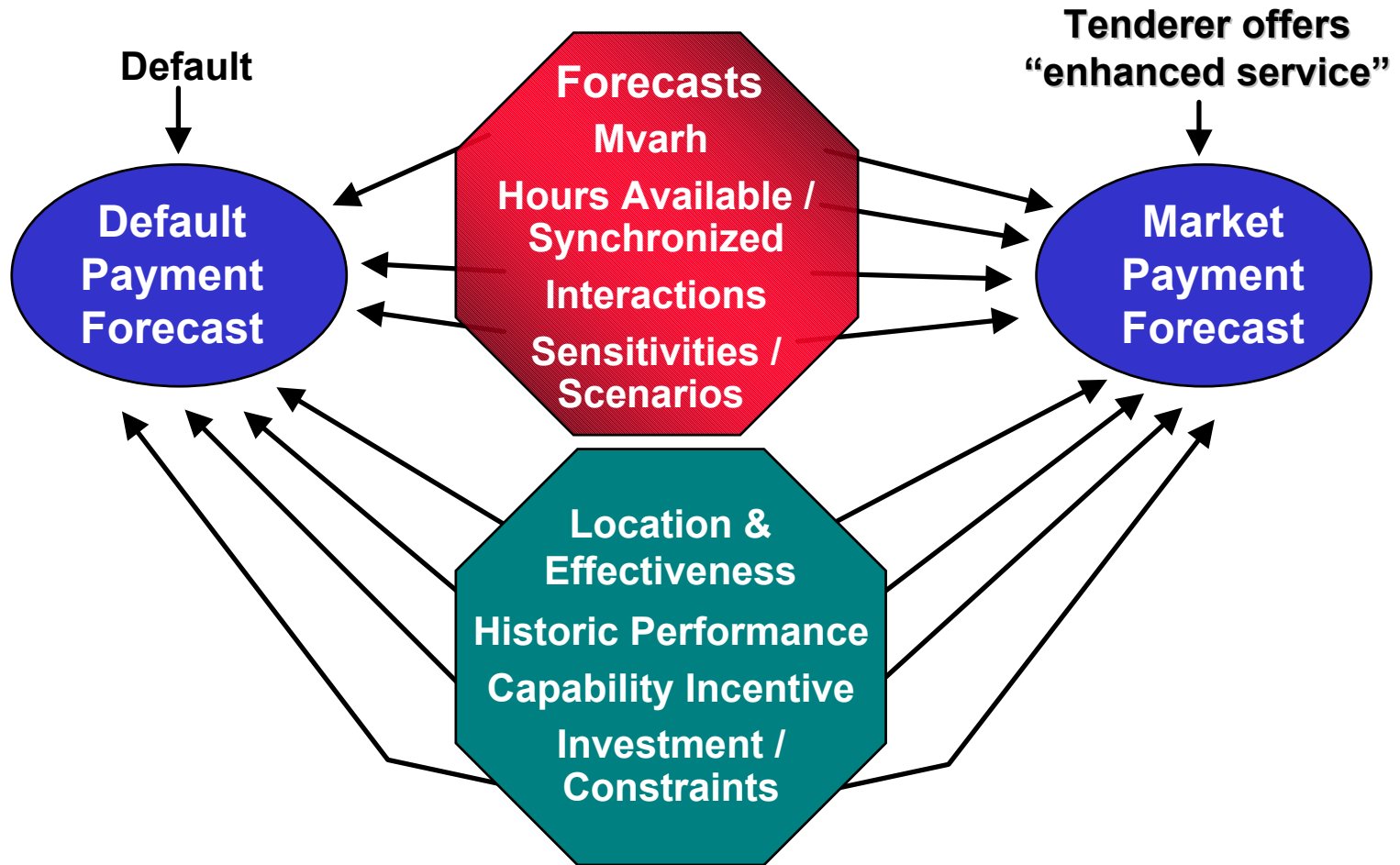
Capability Payments



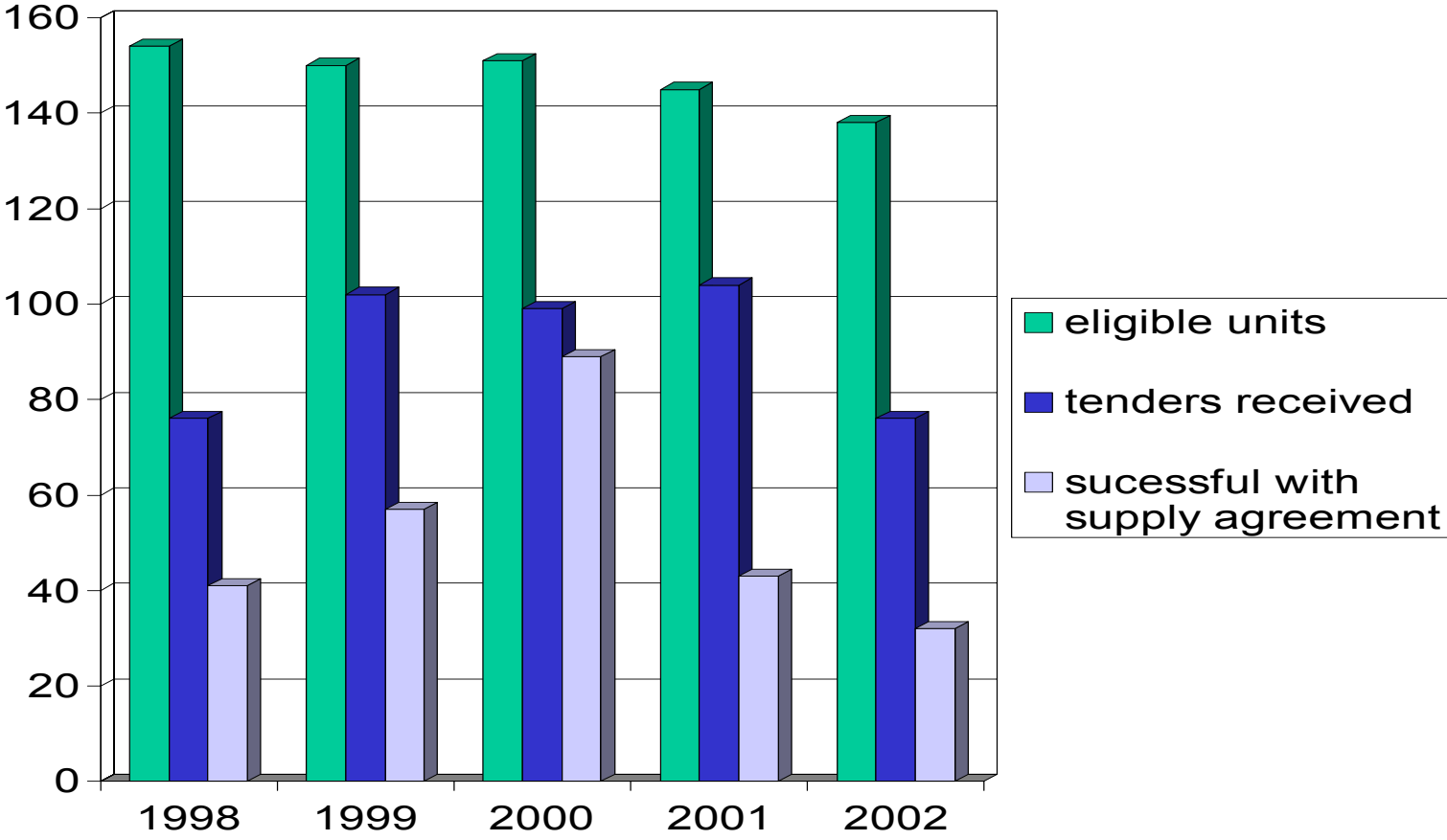
Utilization (£ per Mvarh)



Assessing Tenders



Units participating (April tender round)



Features of “Market” Contracts Interacting with System Operation and Investments

- Generator can use Mvarh price to incentivize National Grid (as System Operator) to despatch unit to low Mvar outputs
- Generator creates own financial incentive to maintain Mvar capability; this may reduce transmission investment needed
- Generator can offer capability in excess of regulatory requirement: can reduce transmission investment needed

New England

Reactive Compensation- introduced 2001

- **Capacity payment made to Qualified Generators**
- **Payment based on lagging reactive capability demonstrated at real power capability**
- **\$1.05/kVAR-year *capability – reduced if active capacity reserve margin more than 20%**
- **Lost Opportunity Payments – active power**
 - Pull back to provide more reactive
 - Synchronous compensation
 - Active power produced for VAR only requirements

New England Other Reactive Sources

- **Capacitors**
 - Capital costs collected by transmission owners through transmission rates
- **Synchronous condensers and FACTS devices**
 - Capital costs collected by transmission owners through transmission rates
 - Real power consumed treated as losses on the NEPOOL transmission system
 - Treatment will be revisited on an as needed basis.
- **Currently considering compensation for merchant HVDC converter reactive output**

New York Reactive Compensation

- **Capacity payments made to all generators under contract to supply Installed Capacity**
 - Other units and synchronous condensers eligible although receive pro-rata payment based on the number of hours run
- **A resource must demonstrate that it has successfully performed reactive power capability testing**
- **Payments require the ability to produce/absorb reactive power within the resource's tested reactive capability, and to maintain a specific voltage level under steady-state and contingency conditions**
- **Payments withheld if unit fails to respond when called upon or following a contingency as determined by NYISO**

New York Reactive Compensation Components

- **Capacity Payment**
 - Annual payment, 1/12 paid monthly
 - Paid to all qualified resources
 - Equal to \$3.919/kVAR-yr for qualified VARs
- **Lost Opportunity Payment**
 - Paid to units dispatched down to provide reactive supply
 - Equal to the MW reduction times LMP minus the generators energy bid (lost infra-marginal revenue)

New York Other Reactive Sources

- **Capacitors, synchronous condensers and FACTS devices**
 - Capital costs collected by transmission owners through transmission rates
- **TCCs (FTRs) awarded if installation increases transfer capability**

Summary

- **RP not commodity – very locational**
- **Simple RP payments appear to deliver system needs without impeding active markets**
 - Benefits of complex arrangements?
- **Some limited evidence of Reactive payments interacting with Transmission investment in UK**