Project EDGE | DER Network Market Optimisation

Demonstrations Insights Forum | 18 May 2022

Agenda

Item	Lead	Timing
Welcome, Acknowledgement of Country	Ryan Batchelor (Nous)	5 min
Quick project status update	Nick Regan (AEMO)	10 min
DER network market optimisation presentation	Pierluigi Mancarella (UoM)	40 min
Close and next steps	Ryan Batchelor (Nous)	5 min

Acknowledgment of Country

We acknowledge the Traditional Owners of country throughout Australia and recognise their continuing connection to land, waters and culture.

We pay our respects to their Elders past, present and emerging.

Project EDGE update

Current position

- The EDGE trial has officially started with the platform and marketplace going live on May 2.
- Basic functionality of the marketplace is being tested (DOE generation, boffers, telemetry)
- The project is in discussion with three additional aggregators to come on board for participation in EDGE in September 2022.
- The Project EDGE Research Plan has been published on the AEMO website

Key upcoming activities

- Release of the Public Interim Project Report and Public Customer Insights and Engagement Study Report
- Public webinars for these public reports.
- Further develop platform capability and sophistication.
- Progress customer acquisition for next phase (including additional) C&I customers

What are we testing in practice?

We will cycle the trial through a number of pre-determined modes that test permutations on DNSP operating envelopes and aggregator bidding.

Mode	OE Frequency	DOE calculation	OE Active vs. Reactive	DOE Objective function	Bidding Type	Bidding	Bidding Qty	Dispatch instruction
1	Day ahead	Network + approximation	Active only	Equal allocation	Scheduled bidding	Visibility	Net NMI	Not actioned
2	Day ahead	Network only	Active only	Max service	Scheduled bidding	Visibility	Net NMI	Not actioned
3	Day ahead	Approximation only	Active only	Max service	Scheduled bidding	Visibility	Net NMI	Not actioned
4	Day ahead	Network + approximation	Active only	Max service	EFL	Self-dispatch	Net NMI	Actioned
5	Day ahead	Network + approximation	Active only	Max service	Scheduled bidding	Scheduled	Net NMI	Actioned
6	Day ahead	Network + approximation	Active only	Max service	Scheduled bidding	Scheduled	Flex	Actioned
7	Intra-day	Network + approximation	Active only	Max service	Scheduled bidding	Scheduled	Net NMI	Actioned
8	Intra-day	Network + approximation	Active + Reactive	Max service	Scheduled bidding	Scheduled	Net NMI	Actioned
9	Intra-day	Network + approximation	Active + Reactive	Max service	Scheduled bidding	Scheduled	Flex	Actioned

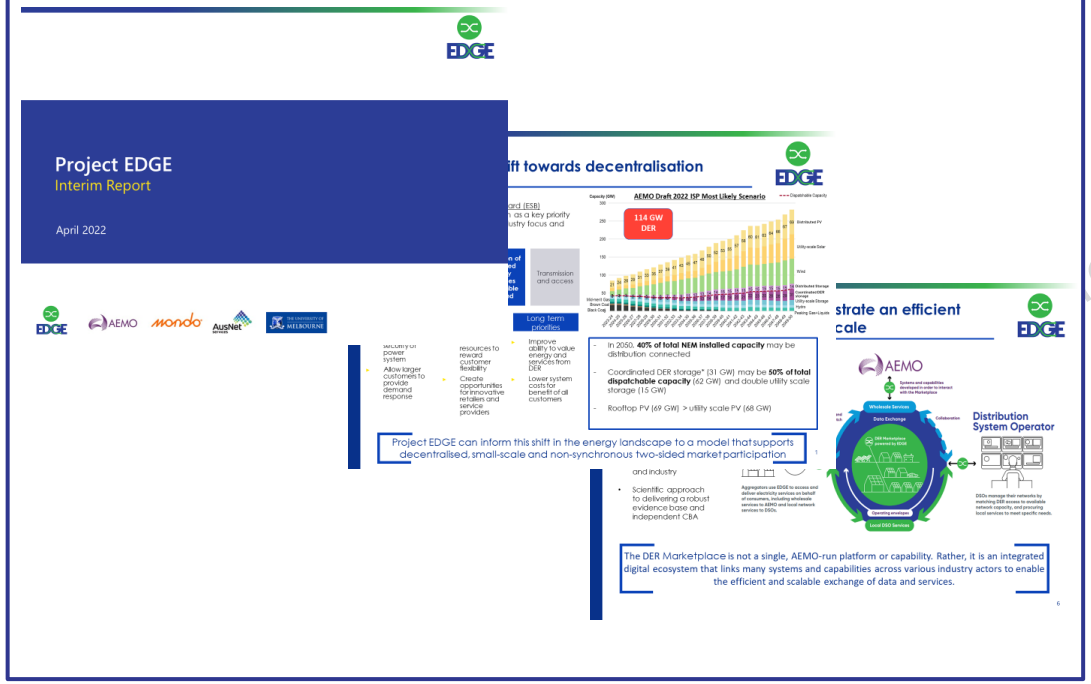
How will we ensure relevance and robustness of results?

We will be actively testing several scenarios to ensure test results include data with these important market conditions

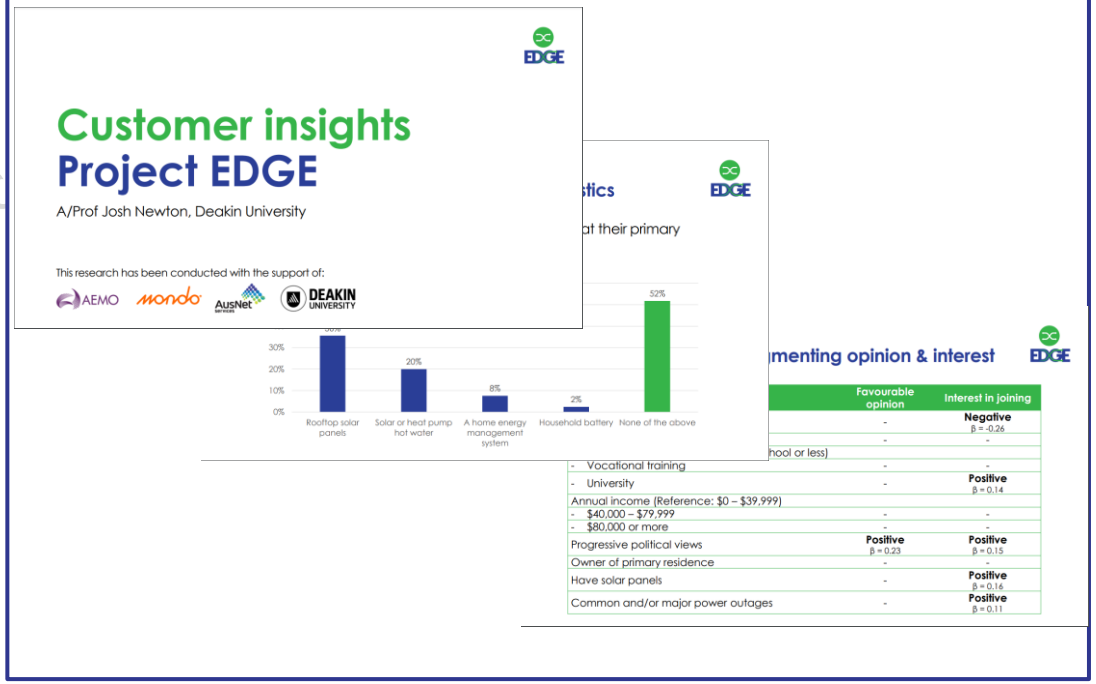
	Scenario 2: DER Energy Arbitrage	Scenario 5: Market response to communication failures
Scope	1. Sudden unforeseen price spike to ceiling (e.g. gen trip) 2. Sudden unforeseen price spike to floor (e.g. loss of load) 3. Administered Price Cap (APC) 4. High volatility day (e.g. saw toothing) 5. Lack of Reserve (LOR1) days 6. Minimum System Load (MSL1) days	1. Loss of connection between DNSP and AEMO • (e.g. cease DOE, use remaining 48hrs) 2. Loss of connection between Aggregator and AEMO • (e.g. cease boffer, use remaining 48hrs) 3. Loss of connection between Aggregator and DER assets • (e.g. cease dispatch, DER default control) 4. Loss of connection between AEMO and Aggregator • (e.g. cease dispatch instruction, maintain last instruction)
Purpose	• Demonstrate Aggregators' ability to respond to price events with a high level of accuracy to their scheduled dispatch target • To understand if Aggregators' can coordinate DER fleets to respond instantaneously to negative/high price events • Better understanding of contingency events for improved forecastability of VPPs	• Determine how resources/systems perform during communication outages • Inform what the optimal default arrangements should be under loss of communications (e.g. DOEs, boffers, dispatch instructions) • Understand impact of communication failures on market outcomes (spot price, customer resource utilisation)

We will be publishing two major reports at the end of May

Public Interim Project Report & Webinar



Public Customer Insights and Engagement Study & Webinar



MAY — *Today* — JUNE — JULY

Public report release — Webinar

DER network market optimisation presentation

University of Melbourne

The work presented today will support Research Questions 5 and 7

Research questions			Hypotheses	
Local network services	RQ.5	How can the DER Marketplace facilitate efficient and scalable provision of local network support services from DER so that network efficiency benefits are realised for all customers?	Hp.A	Network reliability can be managed through the provision of local network services from customer-owned assets.
			Hp.B	The barriers to DNSPs relying on local network services from DER can be overcome through proper design of procurement mechanisms.
			Hp.C	It is possible to standardise the characteristics and procurement of local network services so that aggregator-DNSP trade of these services can be consistent between regions.
DNSP investment and capability	RQ.7	How could DNSP investment to develop DSO capabilities improve the economic efficiency of the DER Marketplace?	Hp.A	There is an optimal combination of DNSP investment in network and DER based non-network solutions which results in higher economic efficiency and improved operation of the DER Marketplace as DER penetrations and density increases.

Full Research Plan is available on the Project EDGE website.

Project EDGE:
DER and Market Interaction Studies

Demonstration Insights Forum (DIF)

Dr Shariq Riaz, Prof Pierluigi Mancarella

pierluigi.mancarella@unimelb.edu.au

Power and Energy Systems Group

The University of Melbourne

18th May 2022

Agenda

- Key takeaway messages
- EDGE and local markets
- Wholesale energy market and local network services co-optimization
  - Fundamental techno-economic principles and methodology
- Increase of network hosting capacity and associated market value
  - Toy examples
- Discussion and feedback

Key takeaway messages

- Based on the results obtained so far, **co-optimization of wholesale and local services** (*integrated energy and network markets*) can unlock DER potential to provide **social welfare benefits**:
  - Wholesale and local energy market operational savings
  - Savings in procurement of local network services/investment cost
  - Cost savings/increased revenue opportunities for consumers and aggregators

Key takeaway messages

- *Local services* can unlock DER potential to participate in *wholesale markets*, thus increasing **the efficiency of both distributed and wholesale energy markets**
- DER provision of *local network services* can **decrease the cost of procuring local balancing services and investing into network/non-wire asset**
  - Opportunity for provision of new services emerge for DNSPs/DSOs
- **New business case opportunities** emerge for DER owners and aggregators **to provide local services** on top of wholesale market services
- Non-DER consumers too are exposed to **lower *energy and network* costs**
- **Regulatory changes** will be needed to be able access the full value of co-optimised energy and network operation

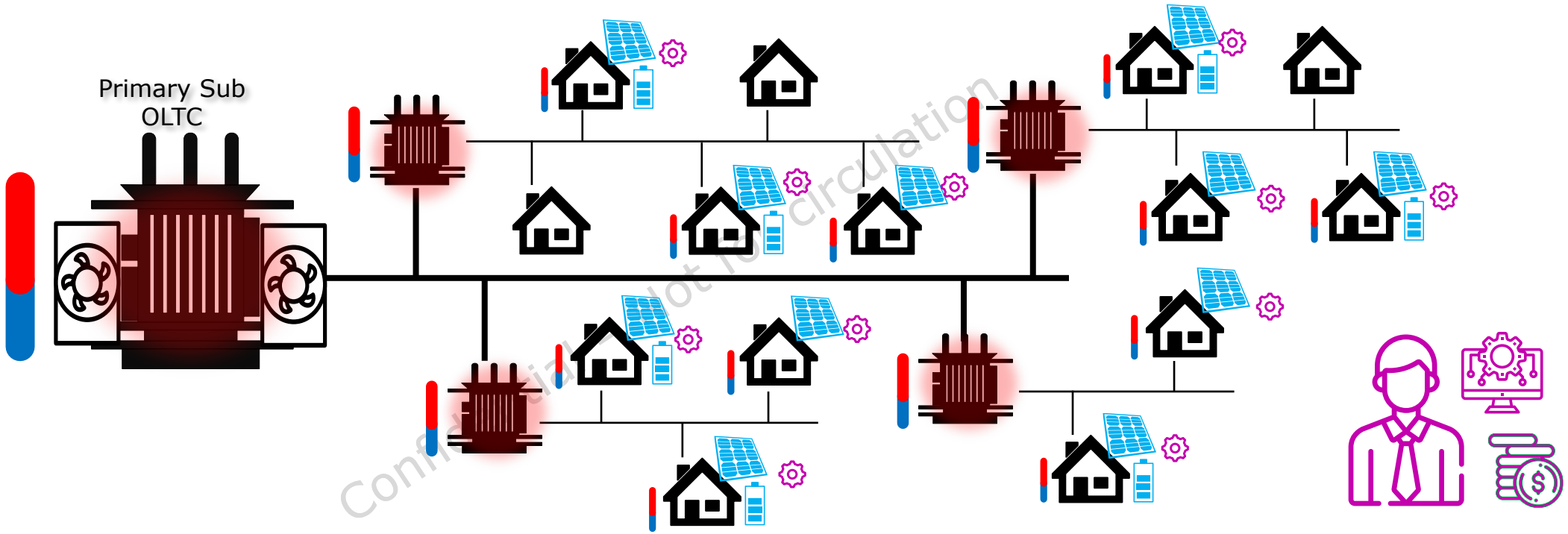
Background about UoM work in EDGE

- In the context of project EDGE, the University of Melbourne has been engaged by AusNet Services to perform:
  - Network Studies
    - Development of operating envelope algorithms
  - ***DER and Market Interaction Studies***

DER and market interaction studies: Scope and deliverables

- Co-optimization of wholesale energy services and local network services, including consideration for DER provision of active and reactive power
  - Definition of possible use cases
  - Investigation of the effects of DER services on operating envelopes
  - Process flowcharts with techniques for DSO platform implementation
  - Simulation and visualisation of market co-optimisation scenarios

Bottom-up services and networks impacts

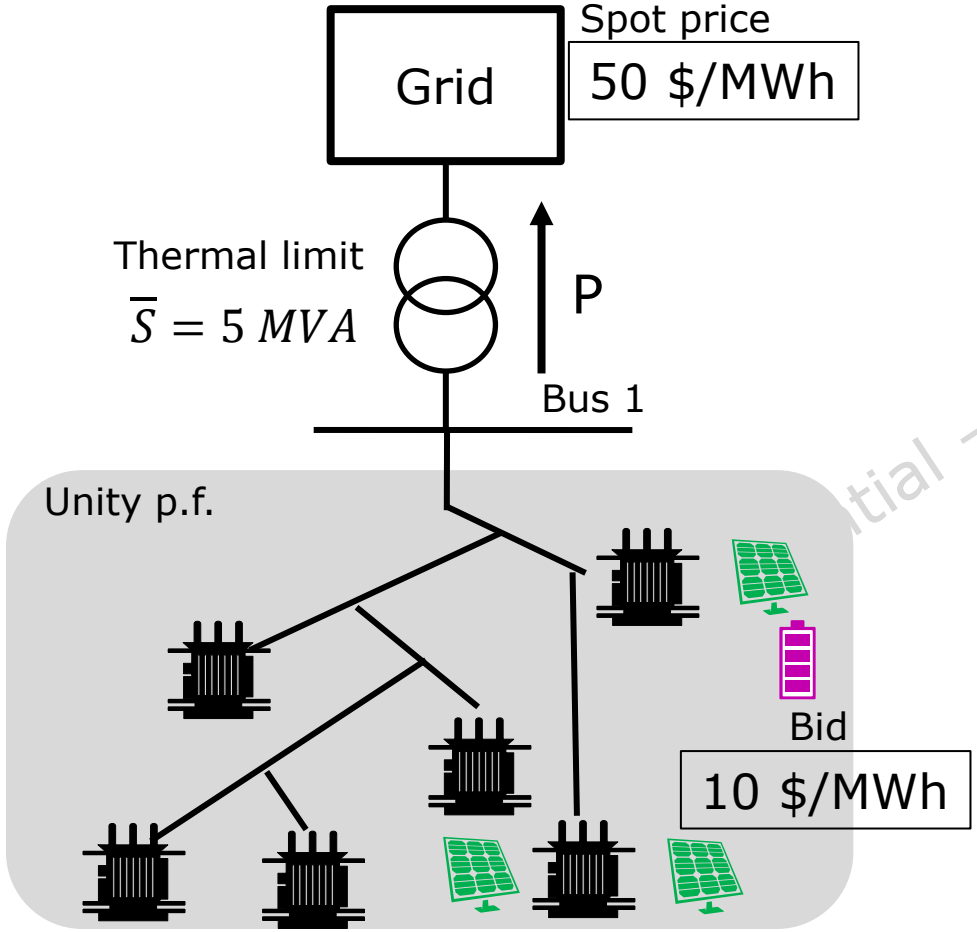


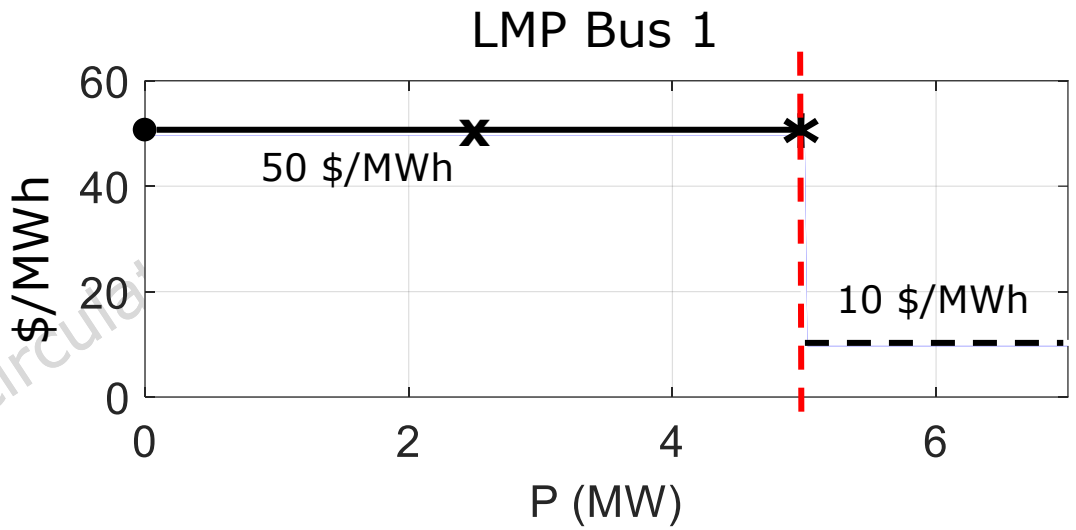
Aggregation of DER → Bottom-Up Services → **Network Problems**

Fundamental principles to value active and reactive power services

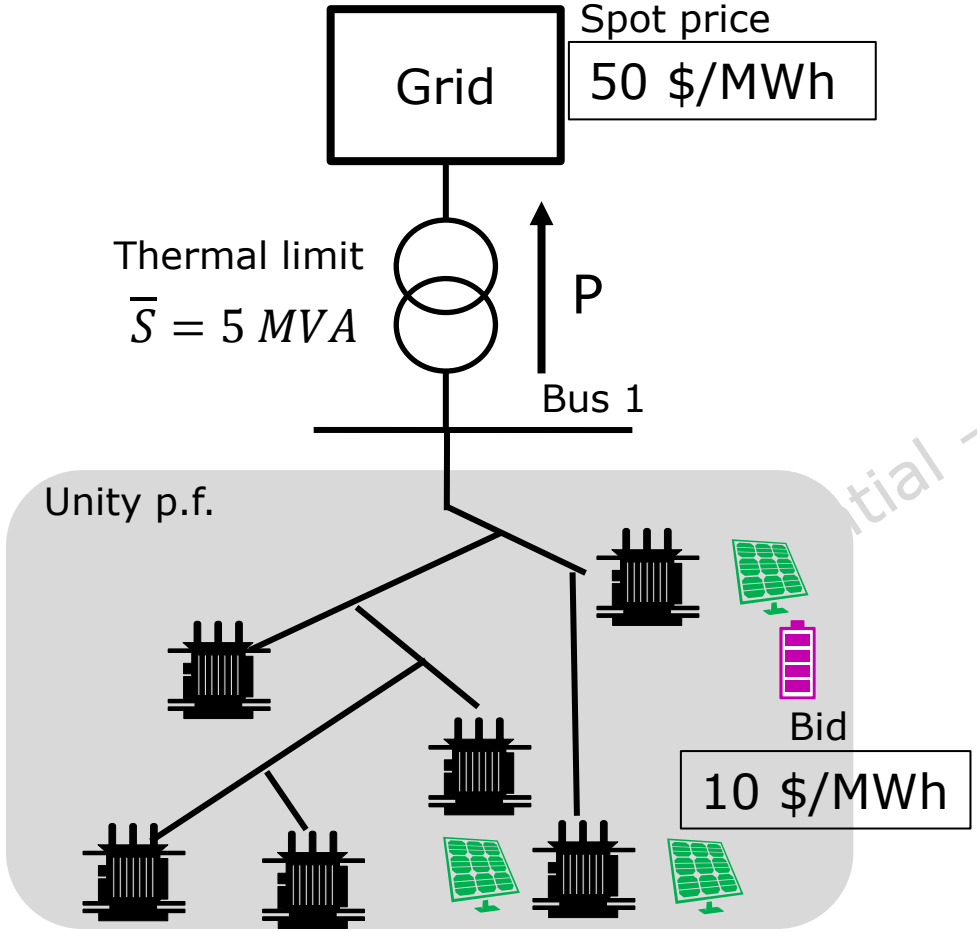
- Thermal and voltage constraints are the main network drivers that affect value in distributed energy systems and markets
- We need a methodology that can seamlessly and consistently capture physics and economics
- From transmission systems and wholesale markets, we know that **locational marginal pricing** (LMP) theory can adequately assess the value of active power services at different locations
- Our modelling aims to extend LMP applications to **distribution networks** and **reactive power valuation**
- Note:
  - LMPs are not necessarily meant to be used directly as price signals for DER, but rather and more generally to establish a robust *valuation* framework to assess different forms of payments, contracts, etc.

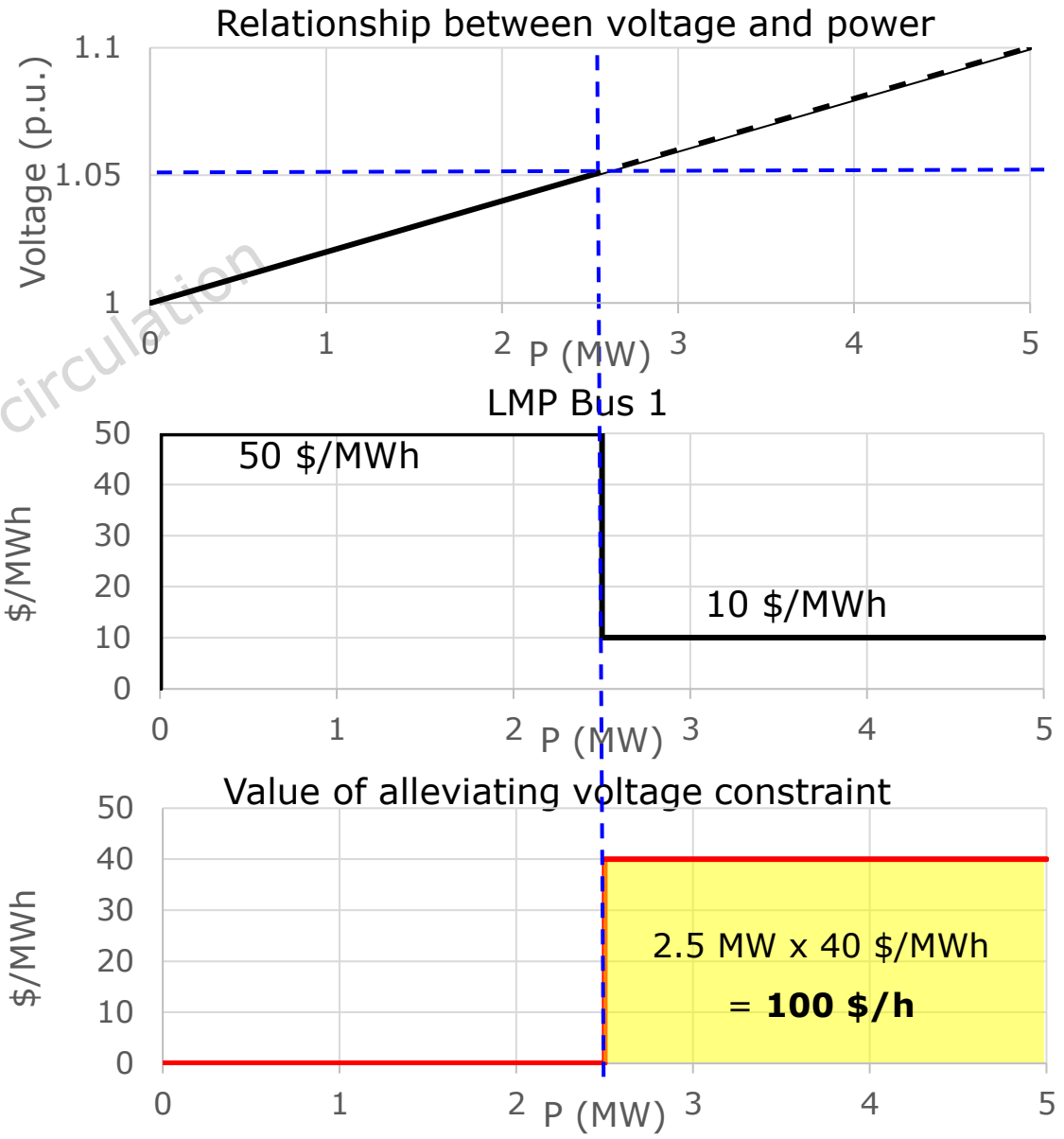
A first toy example: impact of transformer thermal limits on export



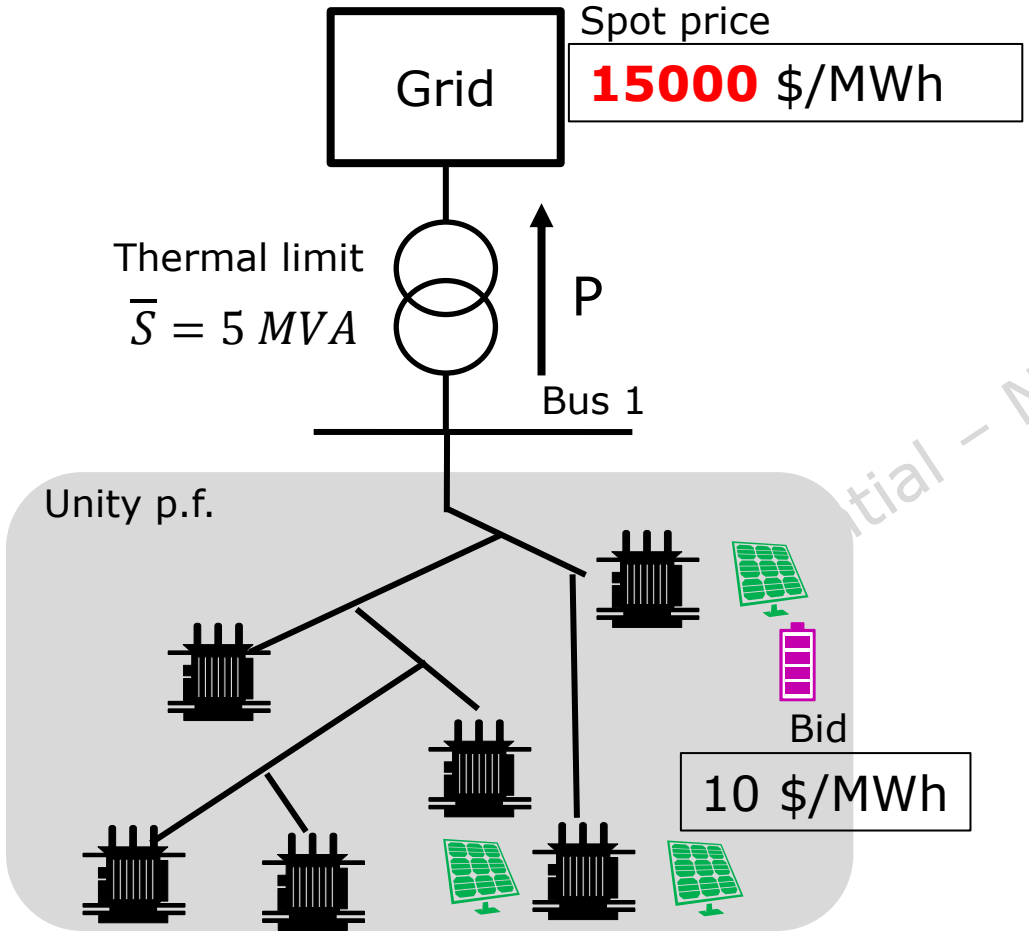


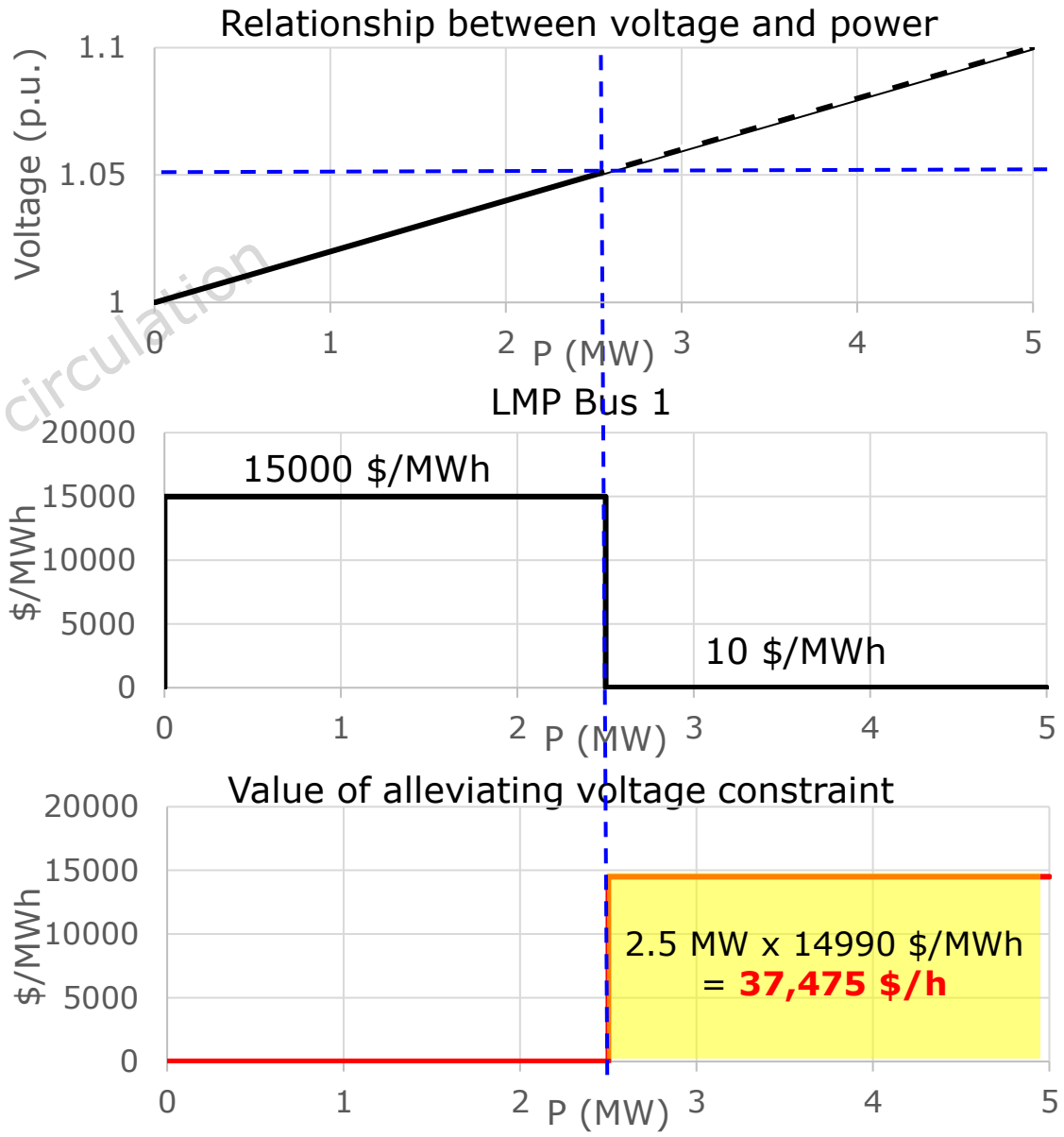
Another toy example: Impact of voltage constraints



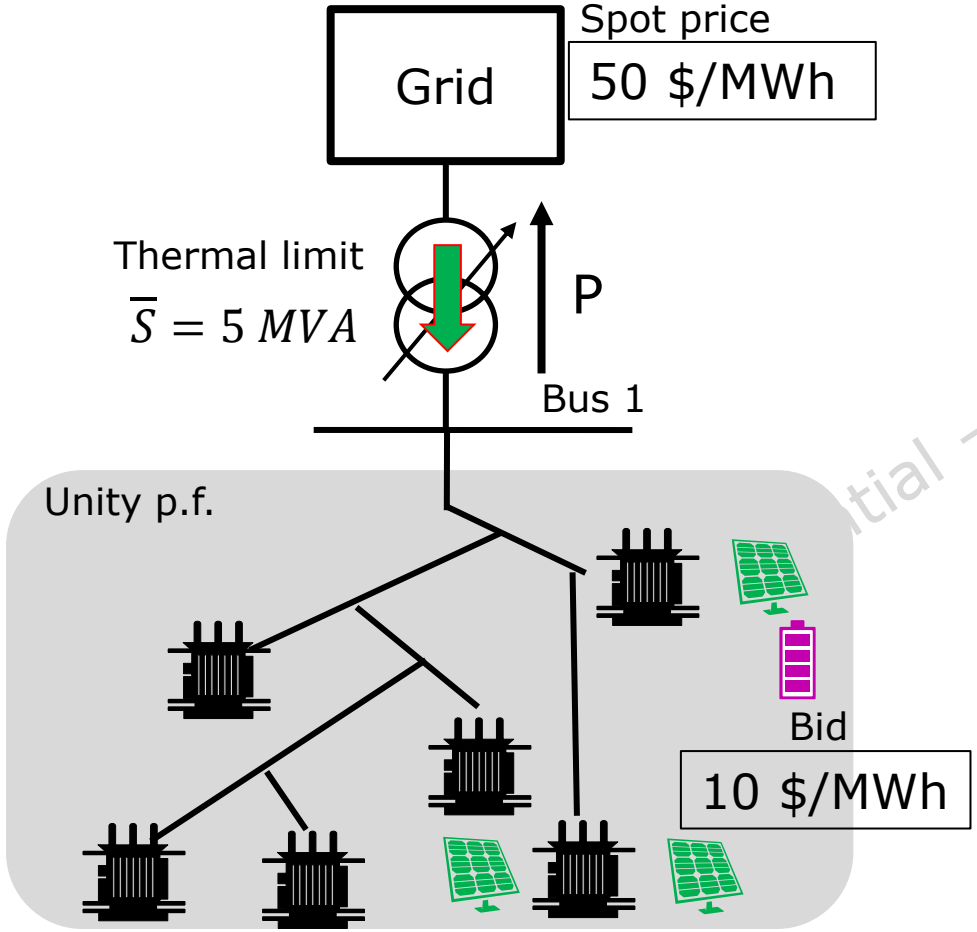


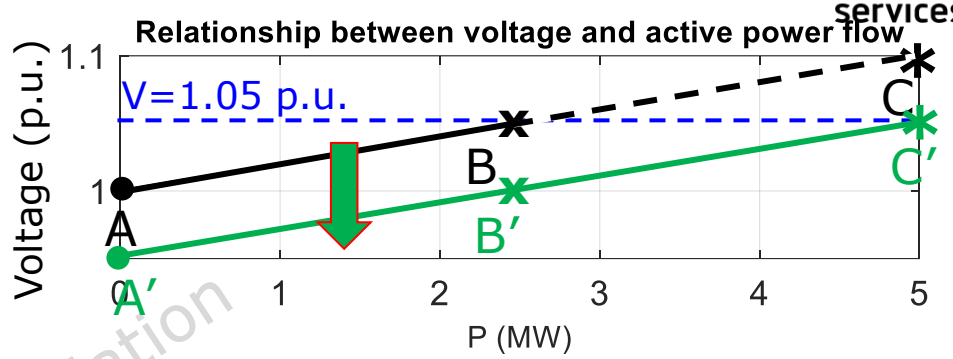
Impact of voltage constraints with peak price

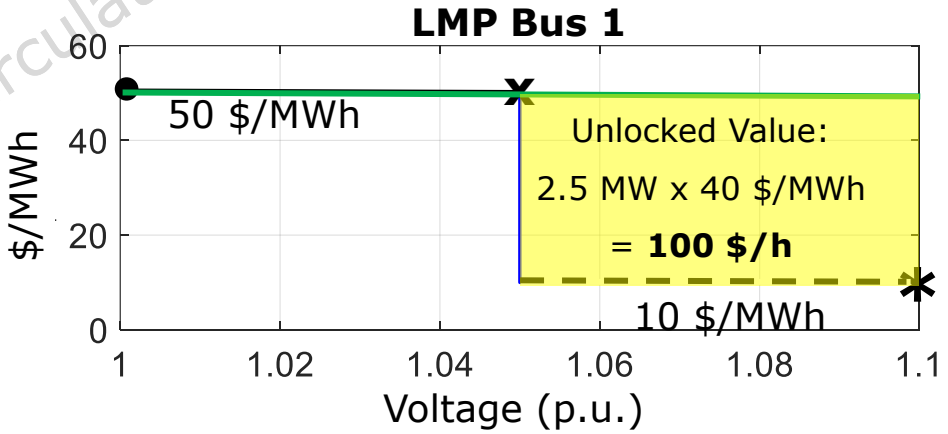


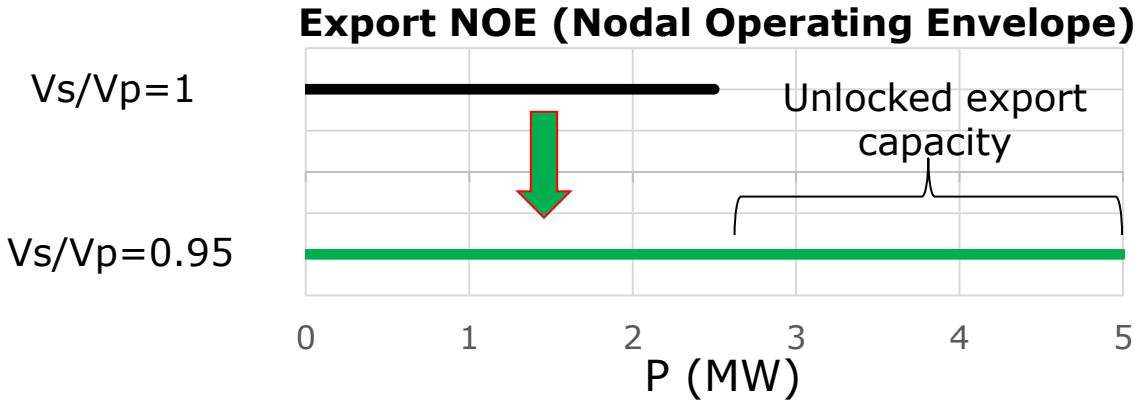


Value of OLTC operation to increase export capacity

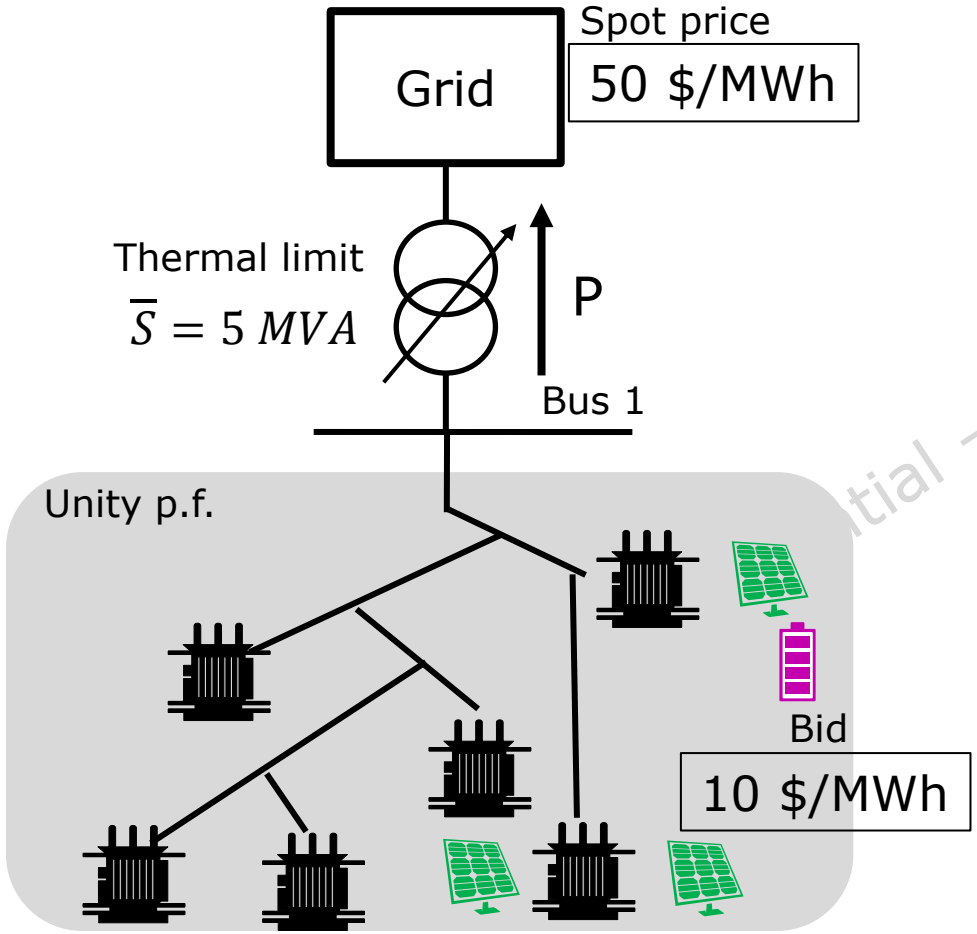


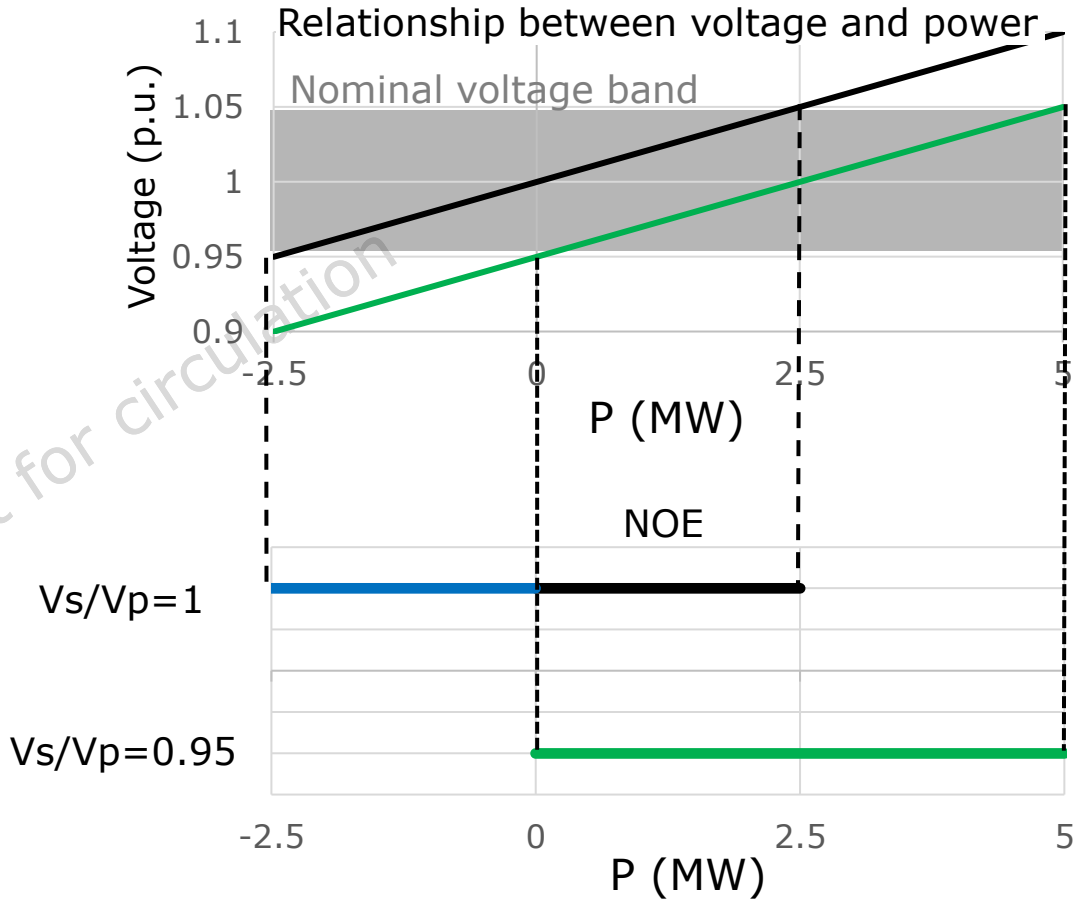




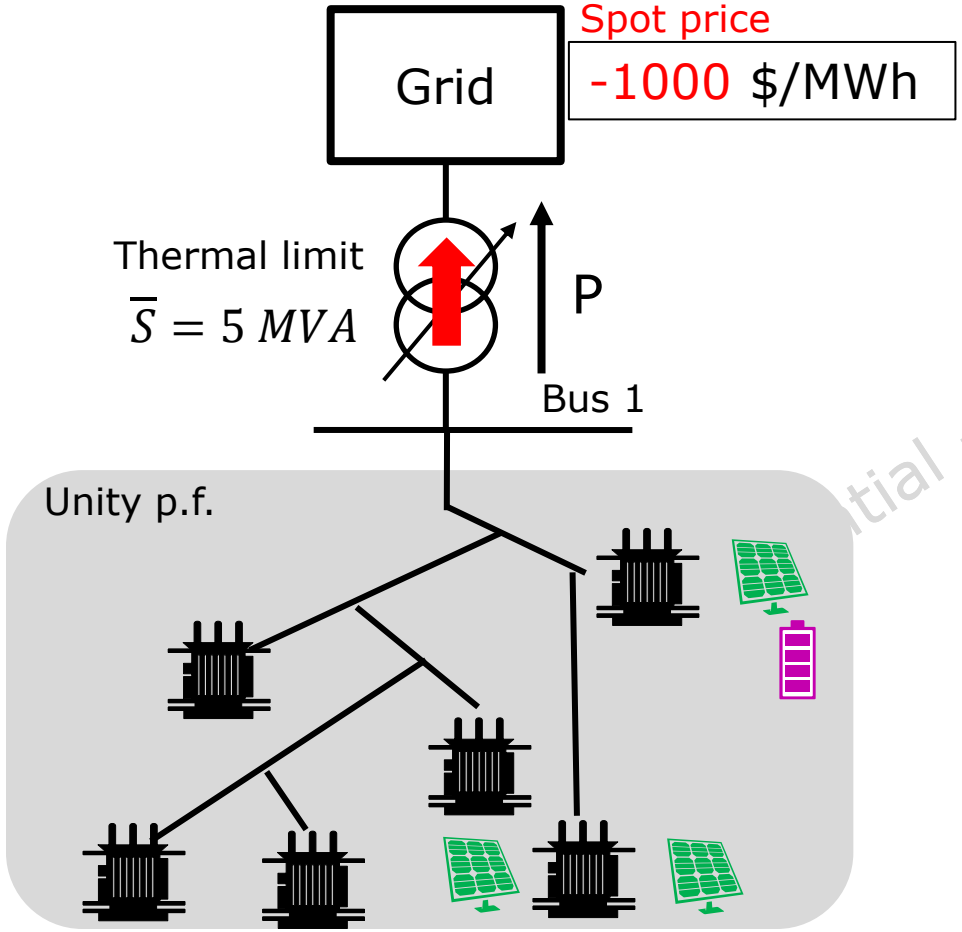


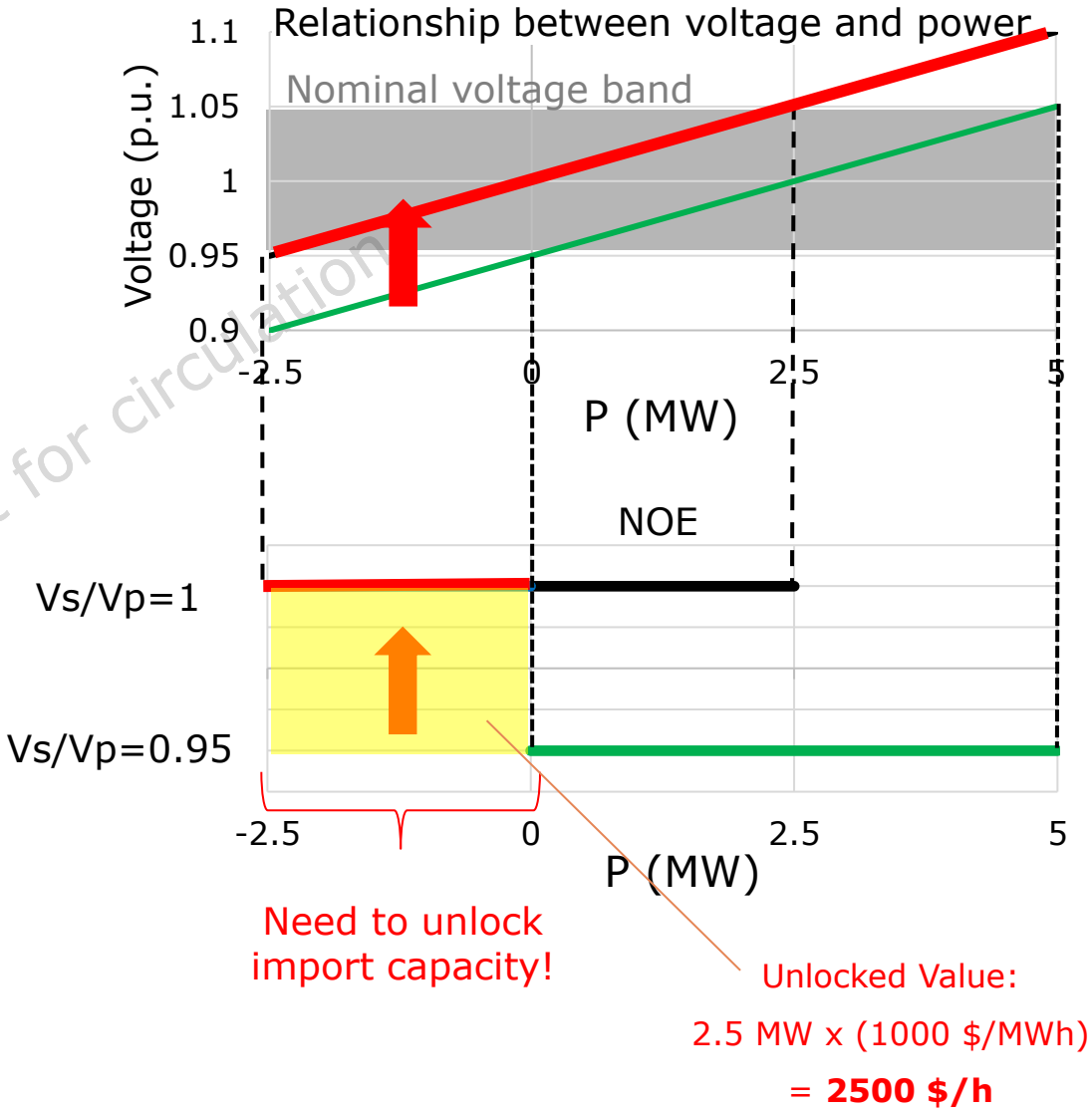
Impact of OLTC operation on export and import



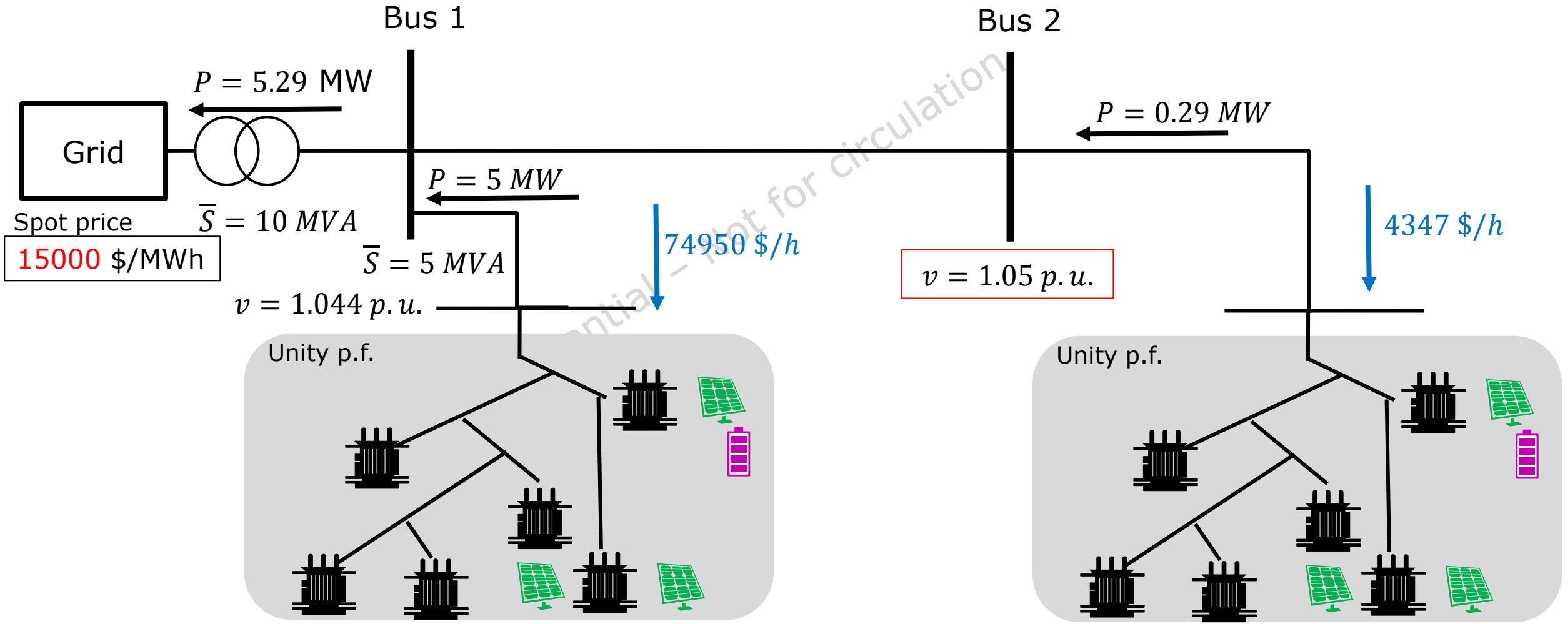


Need to actively co-optimise network and wholesale market services

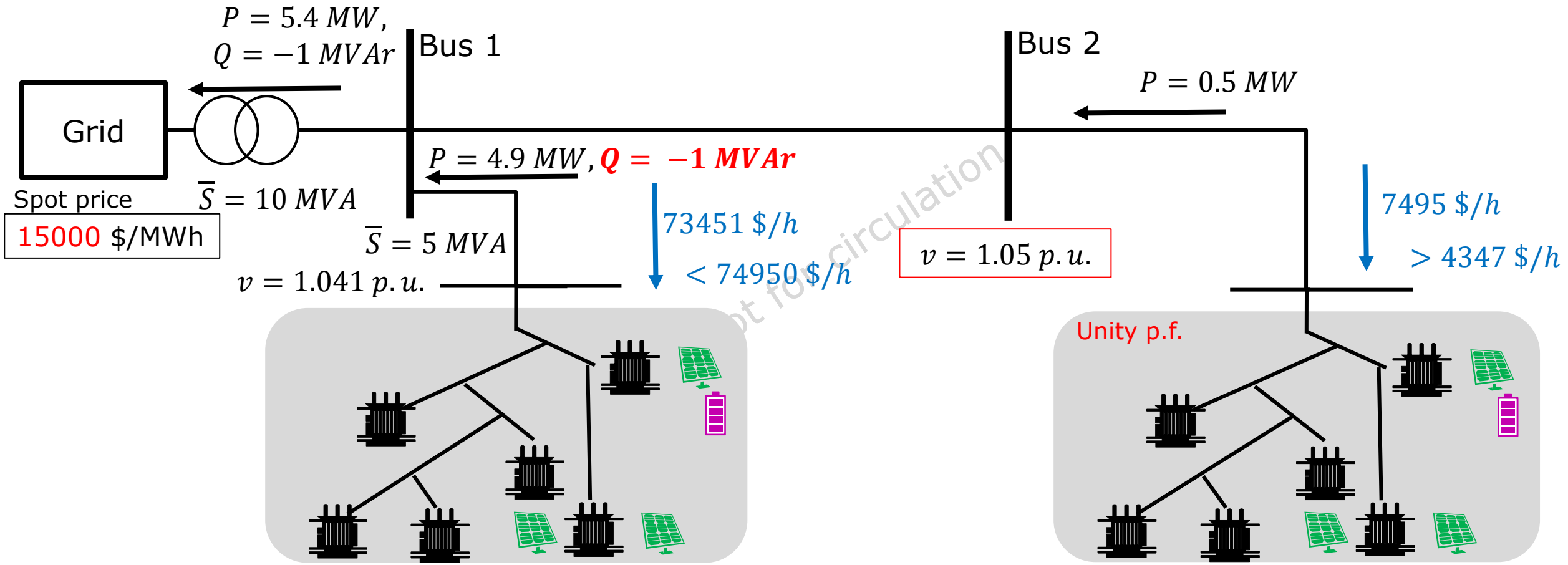




Impact of (active power) dynamic operating envelopes on aggregators' cash flows



Locational value of reactive power: DER cooperation



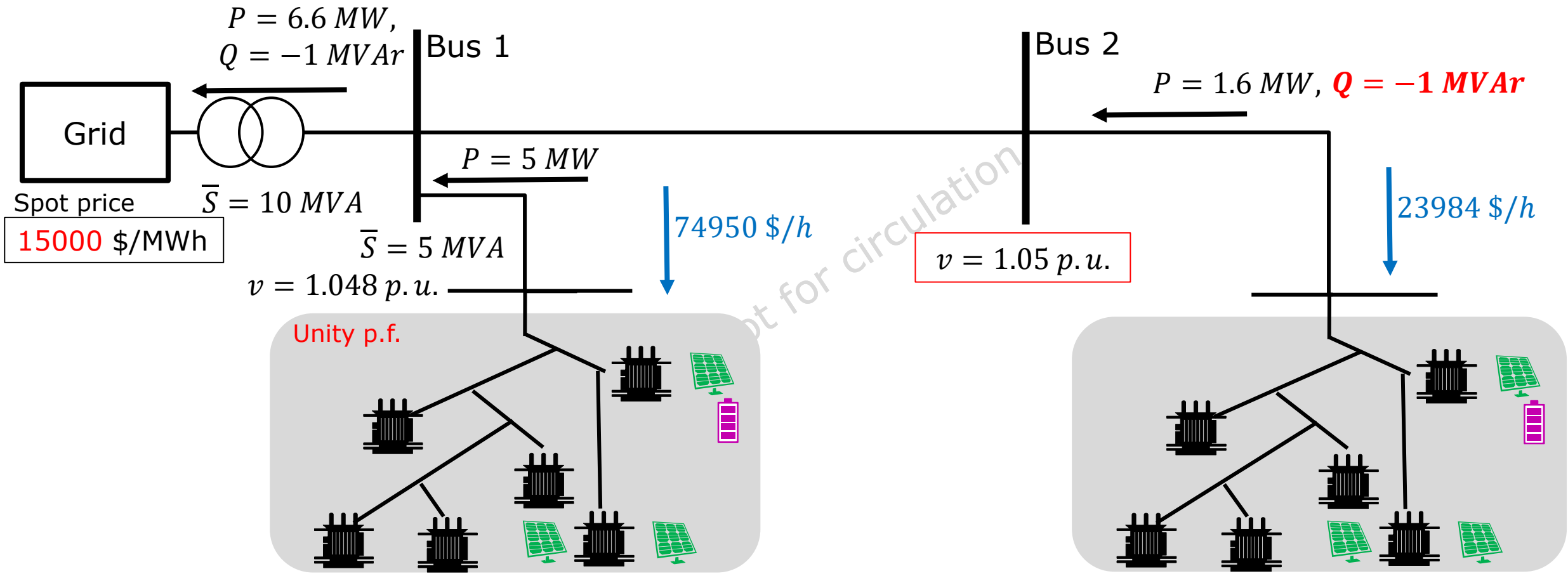
Unlocked active power capacity = 0.11 MW

Required reactive power = 1 MVAr

Value of unlocked capacity = 1649 $/h

Value of reactive power from Bus 1= **1649 $/MVArh**

Locational value of reactive power: DER 2 hub "self-help"



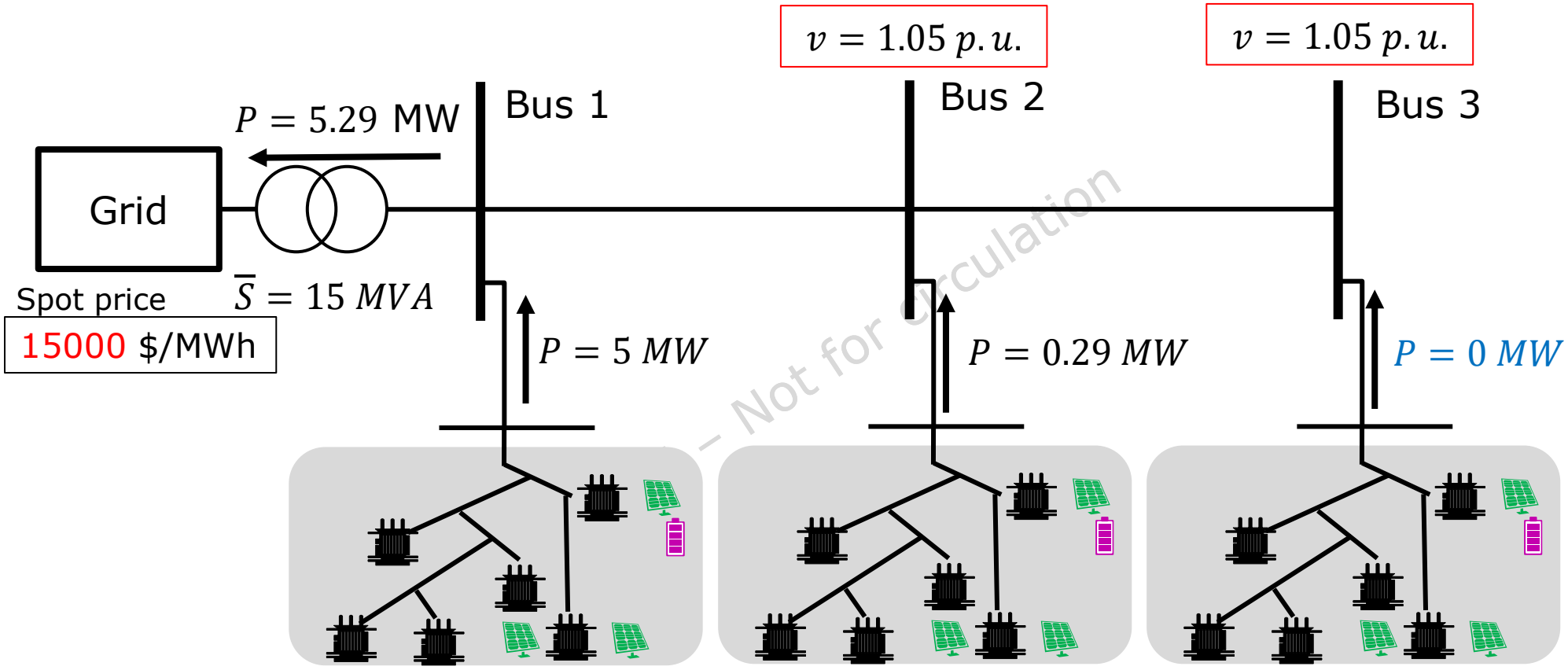
Unlocked active power capacity = 1.6 MW

Required reactive power = 1 MVAr

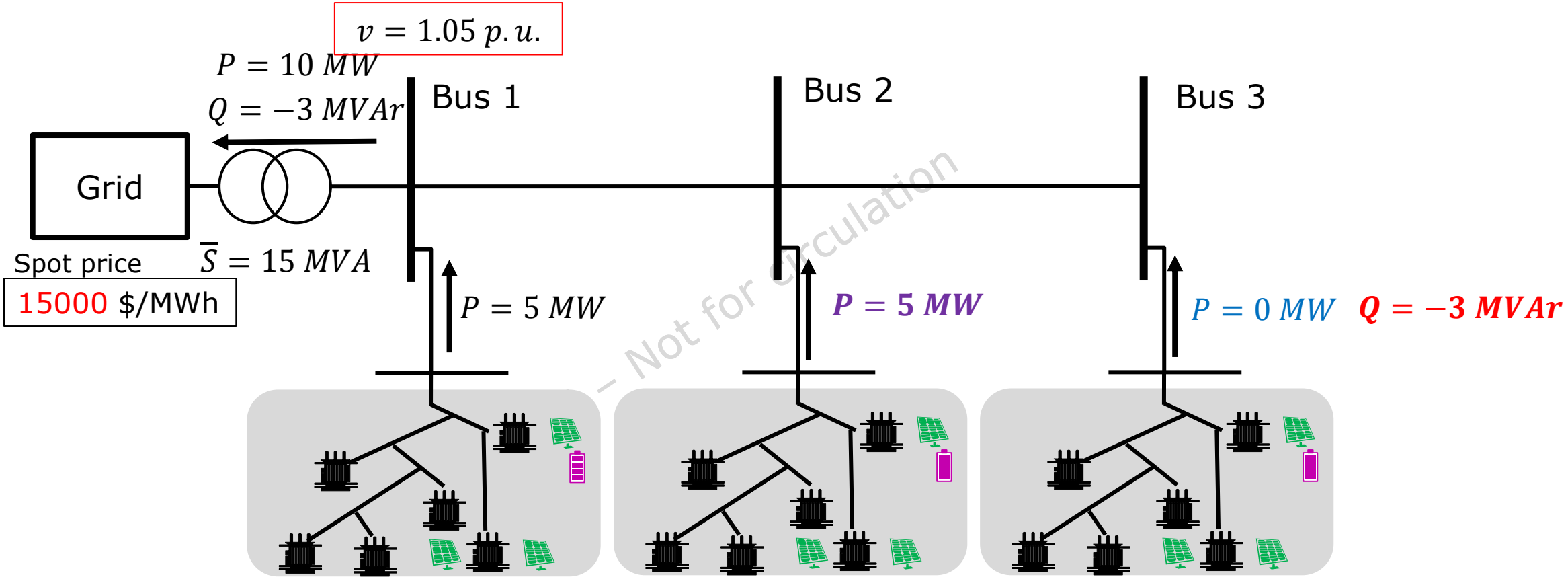
Value of unlocked capacity = 23984 $/h

Value of reactive power from Bus2= **23984 $/MVArh**

DER cooperation and local service procurement: Locational value of reactive power



DER cooperation and local service procurement: Locational value of reactive power



Unlocked active power capacity = 4.71 MW

Required reactive power = 3 MVAr

Value of unlocked capacity = 70602 $/h

Value of reactive power from Bus3= **23,534 $/MVArh**

Final remarks

- ***To unlock the true value of DER and two-sided markets, wholesale market and local network services should be co-optimized***
- Local voltage and reactive power management enhances the aggregated operating envelope (nodal operating envelope), thus unlocking DER capacity for wholesale market participation
- Opportunity for DNSPs/DSOs to define and procure new services accounting for wholesale market dynamics -> market and network co-optimization
- Opportunity for aggregators to provide new services and co-optimize their active and reactive power portfolio, including for self-dispatch
- We are seeking to develop a fundamental techno-economic framework to support the developments of such ***integrated energy and network markets***

Next

- The methodology under development will be used to inform commercial valuation of DNSP/DSO services, e.g.
  - Operation and investment in network asset (e.g., OLTC)
  - DER contracts for high-firmness services (e.g., N-0 capacity services)
  - DER price signals for low-firmness services (e.g., reactive power for intact network)
- Fundamental questions for the **integrated energy-network market design**:
  - How should value be allocated across multiple markets/actors?
  - What is the most suitable commercial framework to do it?

Close and next steps