

Integration of Demand Side Management, Distributed Generation, Renewable Energy Sources and Energy Storages - the role of Ev and PHEV

Workshop on Electricity in the future Transport System
Stockholm 17th September 2009
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Content of the presentation

- ❖ Problems caused by variable output generation
- ❖ Smart-grid challenges and opportunities
- ❖ Demand Response options
- ❖ Aggregator business (case)
- ❖ Where do EV and PHEV fit in?

Problems caused by variable output generation

In electrical networks

❑ network stresses constitutes needs for upgrades to integrate the variable generation.

❑ need for flexible, dispatchable, fast-ramping generation for balancing variations in load or generation

At market:

❑ national and local balances between supply and demand are more **complicated to manage** with high levels of variable-output generation, which can increase total financial electricity costs.

Possible solutions

❑ energy **storages** into the systems (centralised or distributed energy storages DS).

❑ flexibility in electricity **consumption** (demand response DR).

In this sense distributed generation (DG), distributed energy storages (DS) and demand response (DR) can be seen as an integrated distributed energy resource (DER).

Combining the different characteristics of these resources is essential in increasing the value of variable output generation in the energy market.

EV and PEHV can be seen both

❖ as energy storages which can produce services to networks and market

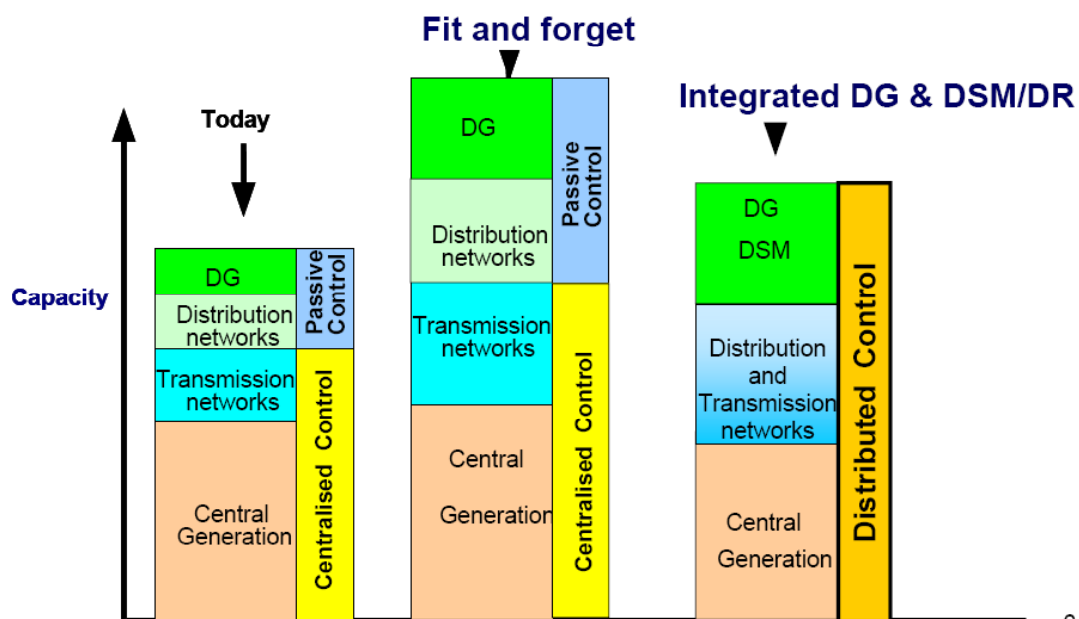
❖ and as flexible loads

Smart-grid vision

The vision for the integration of DER is a **smart-grid platform that would link a web** of diverse generation sources, including a variety of fossil fuels and renewable and distributed sources, across the grid to a large set of consumers with possibilities for improved energy efficiency, local generation, controllable loads or storage devices.

It is expected that the costs of a system with a better DER integration would be reduced compared to the present situation, because of higher energy efficiency and the inclusion of more renewables, but also of a lesser use of expensive peaking power and a better use of the transmission and distribution assets.

Challenges of SmartGrid concepts



Typical incentive based programs

- ❑ **Direct load control:** a program by which the program operator remotely shuts down or cycles a customer's electrical equipment (e.g. air conditioner, water heater, space heating) on short notice.
- ❑ **Interruptible/curtailable (I/C) service:** curtailment options integrated into retail tariffs that provide a rate discount or bill credit for agreeing to reduce load during system contingencies.
- ❑ **Demand Bidding/Buyback Programs:** customers offer bids to curtail based on wholesale electricity market prices or an equivalent.
- ❑ **Emergency Demand Response Programs:** programs that provide incentive payments to customers for load reductions during periods when reserve shortfalls arise.
- ❑ **Capacity Market Programs:** customers offer load curtailments as system capacity to replace conventional generation or delivery resources.
- ❑ **Ancillary Services Market Programs:** customers bid load curtailments in ISO markets as operating reserves.

Aggregator business models of the EU-DEEP project

In the EU-DEEP research project DR as well as DG and storages are employed at small and medium-sized customers. Three business models have been selected for development in view of valuing the benefits of DER in the system and of optimising this value: DER is installed locally where they have the most relevance, but are operated globally to optimise their value.

Business model	Aggregator	Customers	DER technology
1	electricity supplier	medium commercial and industrial	flexible demand, wind
2	electricity and gas supplier	small residential	microCHP
3	energy service company (ESCO)	medium commercial	CHP and flexible demand

Concluding remarks from the IEA Task (1)

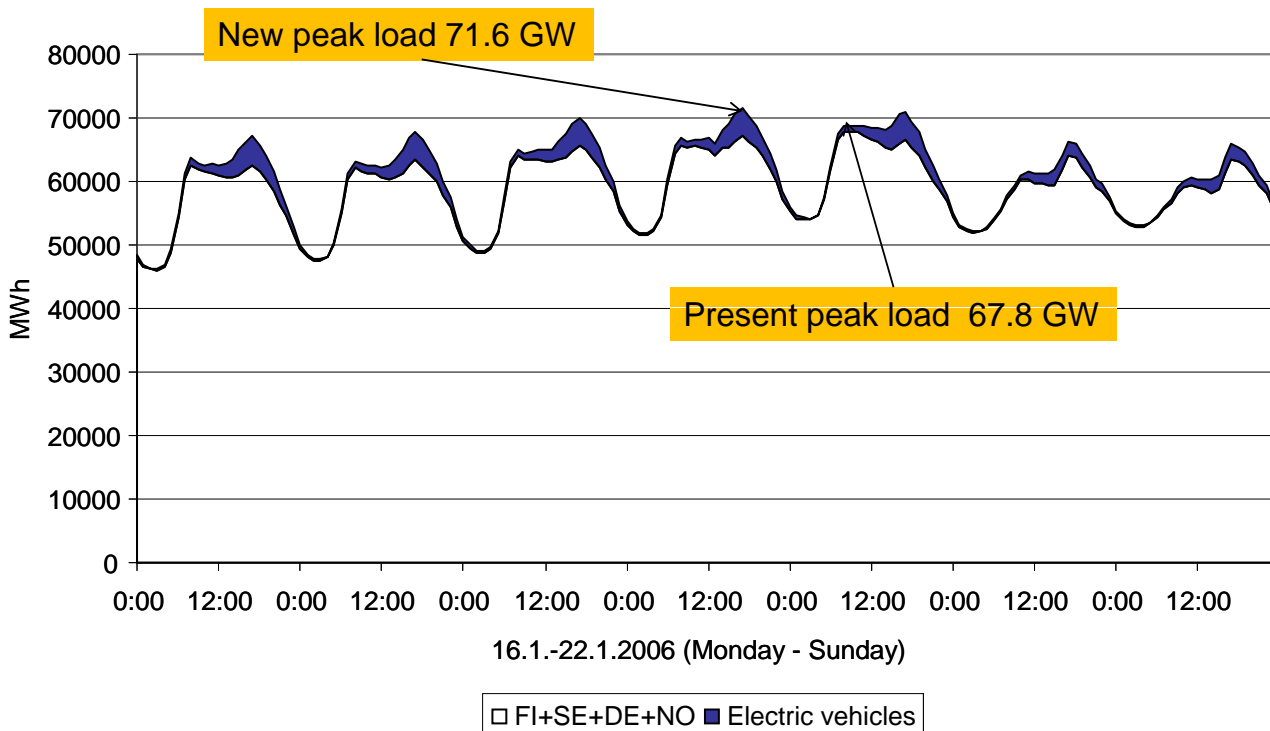
As a conclusion of the analysis it can be said that the increased penetration of DG as well as the technology and market developments result in

- ❑ **new roles of the different stakeholders** meaning new business environment and possibilities; on the other hand new tools are also needed in this new business area,
- ❑ **metering and ICT technologies are developing rapidly,**
- ❑ the above development will result in **new products, services and pricing policies** which can activate the more deep participation of final consumers in the market

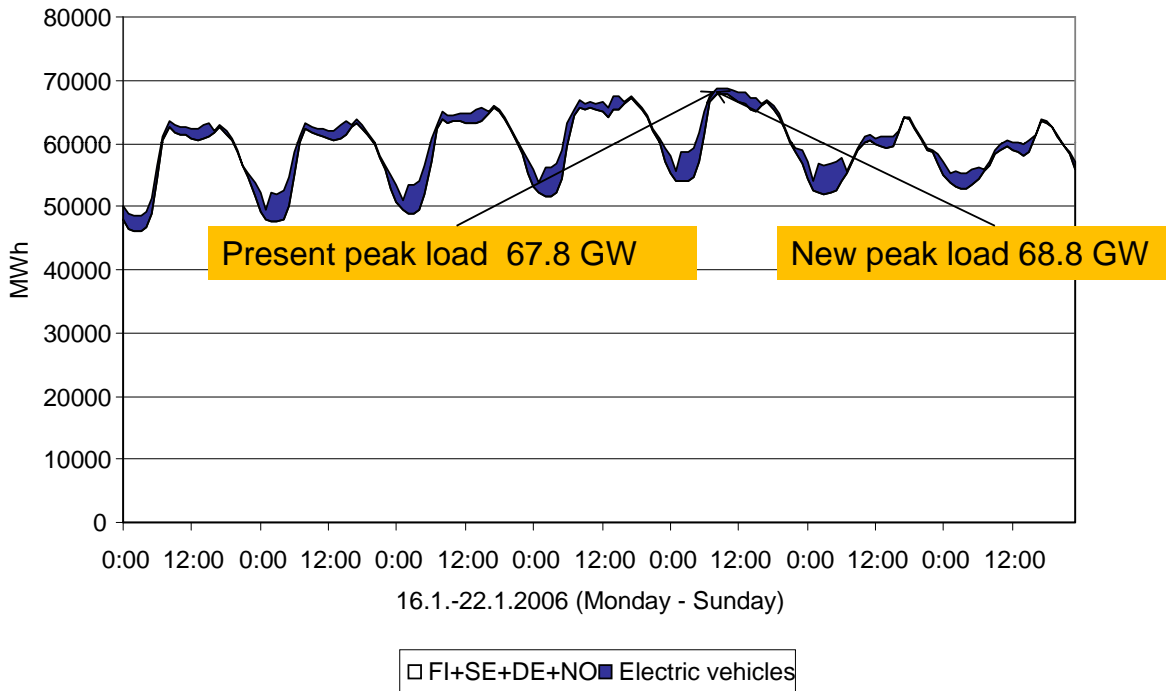
The role of EVs and PHEVs in the integration will be essential in the future as a part of smartgrid development. Also aggregation gives new business opportunities.

In the following slides some examples are given both at Nordic electricity system level and at local distribution network level.

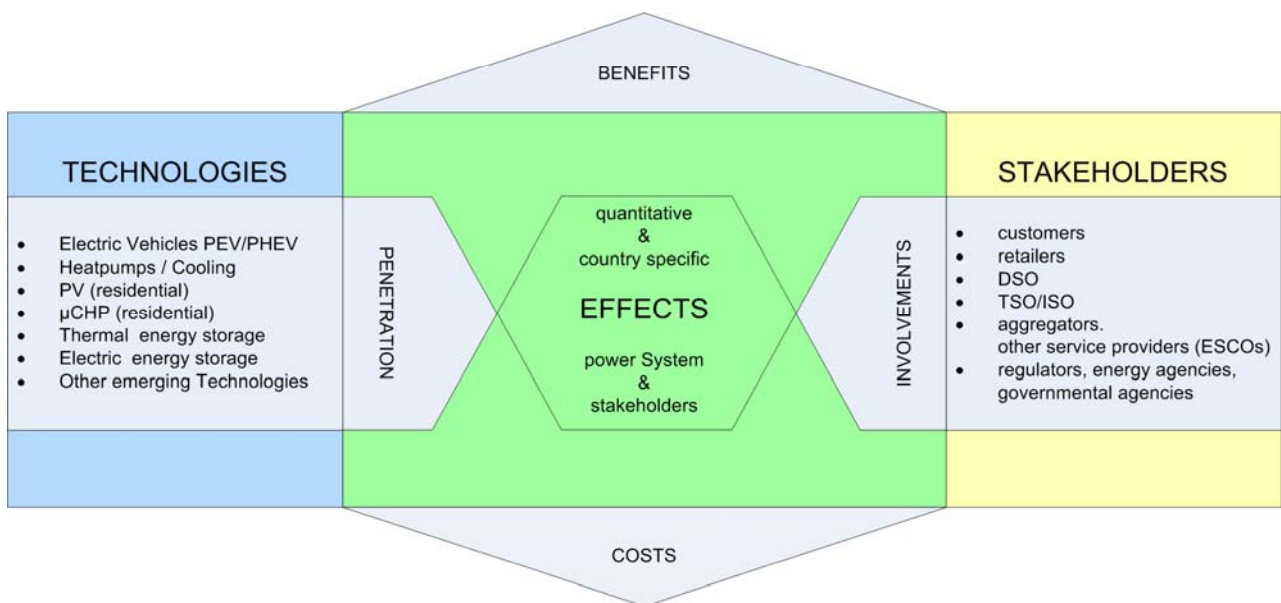
Simulation case 1: 5 million EV/PHEV in Nordic system: normal charging



5 million EV/PHEV in Nordic system: intelligent charging



IEA work continuation



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Thanks

Extra material to follow

Objectives of the Task XVII of IEA DSM

The main objective of the Task is to study how to achieve the optimal integration of flexible demand with Distributed Generation, energy storages and Smart Grids, and thus increase the value of Demand Response, Demand Side Management and Distributed Generation and decrease problems caused by variable output generation (mainly based on RES) both

- ❑ in the physical electricity systems and
- ❑ at the electricity market

The Task deals with distributed energy resources both

- at local (distribution network) level and
- at transmission system level where large wind farms are connected.

The first phase of the Task was a scope study carried in cooperation with seven countries: Austria, Finland, Italy, Korea, Netherlands, Spain and USA

Demand response: Incentive based DR

These programs give customers load reduction incentives that are separate from, or additional to, their retail electricity rate, which may be fixed (based on average costs) or time-varying.

The load reductions are needed and requested either when the grid operator thinks reliability conditions are compromised or when prices are too high (reliability or economy based DR).

Most demand response programs specify a method for establishing customers' baseline energy consumption level. Hence, observers can measure and verify the magnitude of their load response. Some demand response programs penalize customers that enrol but fail to respond or fulfil their contractual commitments when events are declared.

DER business opportunities: market based DER

Typical examples for DG/RES are market price based feed-in tariffs and green certificates and for energy efficiency white certificates.

Correspondingly price-based demand response refers to changes in usage by customers in response to changes in the prices they pay:

- ❑ Time-of-use (ToU): a rate with different unit prices for usage during different blocks of time, usually defined for a 24 hour day. ToU rates reflect the average cost of generating and delivering power during those time periods.
- ❑ Real-time pricing (RTP): a rate in which the price for electricity typically fluctuates hourly reflecting changes in the wholesale price of electricity. Customers are typically notified of RTP prices on a day-ahead or hour-ahead basis.
- ❑ Critical Peak Pricing (CPP): CPP rates are a hybrid of the ToU and RTP design. The basic rate structure is TOU. However, provision is made for replacing the normal peak price with a much higher CPP event price under specified trigger conditions (e.g., when system reliability is compromised or supply prices are very high).

DER business opportunities: market access via aggregators

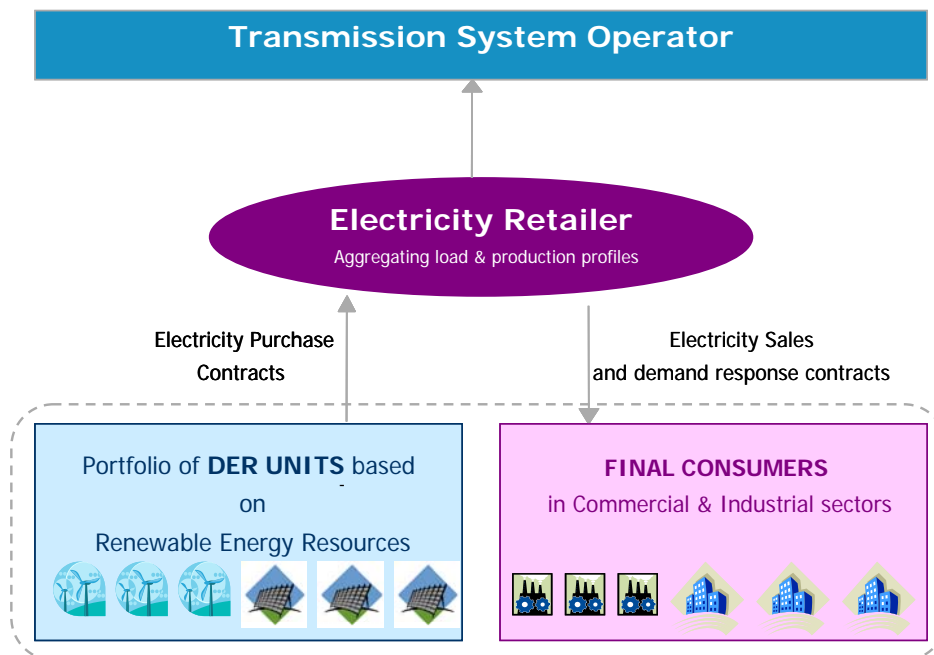
One obstacle in the promotion of Demand Side Integration is that small and medium size customers usually don't have direct access to different types of market either due to the market rules or due to the high transaction costs in market entry. To decrease this kind of barriers a new type of service company, an aggregator, who acts as intermediary between distributed energy resources and energy markets, can emerge

Three main types of aggregators can be defined:

- ❑ **Demand aggregators** collecting demand response (DR) from different types of flexible customers and offering the aggregated DR to different market actors
- ❑ **Generation aggregators** collecting and using a group of dispersed generators in aggregation and offering that into market. This kind of aggregated generation is often called "Virtual power Plant (VPP)".
- ❑ Combination of these.

Internationally, aggregators are most common in the USA market. Also in Australia and Europe some aggregators exist

Business model 1: electricity retailer in the UK (GDF Suez) as an aggregator

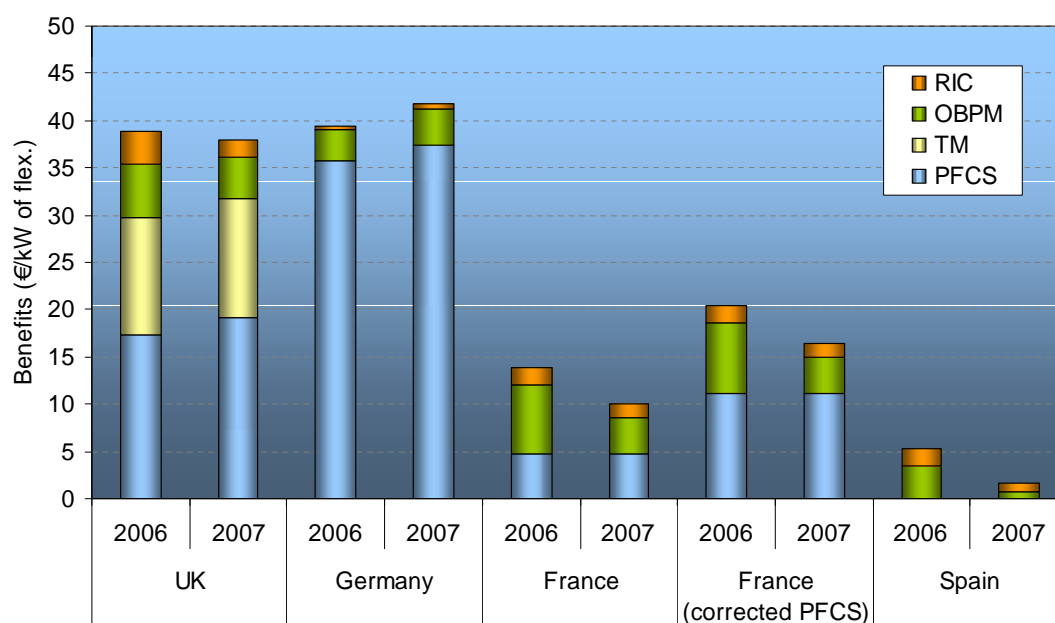


Profits in the UK market

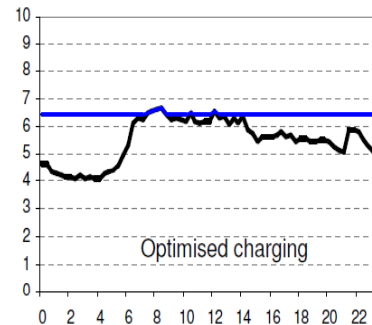
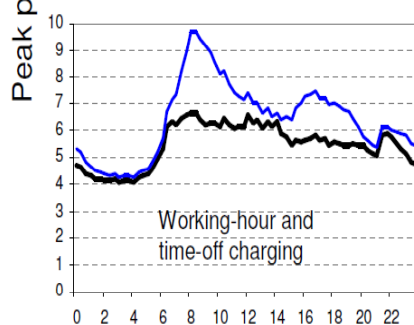
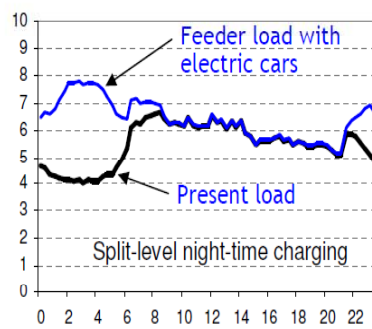
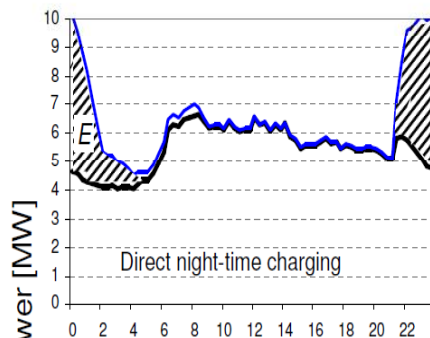
The Aggregator manages this flexibility in order to generate profits, which are shared between him and the customers afterwards. In the UK, revenues from flexibility can be created in 4 different ways, by:

- ❑ offering frequency control services to the TSO (Provision of Frequency Control Services – PFCS)
- ❑ reducing T&D charges (Triad Management – TM), enabled in the UK by a specific Use-of-System charges called Triad,
- ❑ selling power on the wholesale electricity market during high price periods (Obtainment of the Best Price in the Market – OBPM)
- ❑ improving the imbalance position during high penalty moments (Reduction of Imbalance Costs – RIC).

Profitability of the business model 1



Simulation case 2: effect of the charging method on the local network



City area feeder:

- Peak load of the day: 6.6 MW
- Minimum load of the day: 4.0 MW
- **Number of electric cars: 2000**
- Driving distance: 57 km/car,day
- Energy consumption: 0.2 kWh/km
- Charging energy: 11.5 kWh/car,day
→ **22.9 MWh/day for all cars**
- Charging power: 3.6 kW/car
- **Additional power: 0 – 3.5 MW**
(depending on charging method)
- Charging energy (E) is equal in each charging alternative

IEA Work continuation: assessment of the effects of the penetration of emerging DER technologies to different stakeholders and to the whole electricity system

The emerging DER technologies to be discussed include

- plug-in electric and hybrid electric vehicles (PEV/PHEV)
- different types of heatpumps for heating and cooling
- photovoltaic at customer premises
- micro-CHP at customer premises
- energy storages (thermal/electricity) in the connection of previous technologies
- Other technologies seen feasible in 10 – 20 years period, especially by 2020.

The main Subtasks in the Task extension are

- Assessment of technologies and their penetration in participating countries
- Stakeholders involved in the penetration and effects on the stakeholders
- Assessment of the quantitative effects on the power systems and stakeholders
- Conclusions and recommendations