Microgrid

Presenter: Victor Dunand

Agenda

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1. Key driver for microgrids?
2. What is a microgrid?
3. Frequently asked questions answered
   - Impact of DER on Electrical network
   - Control strategy
4. 3 Case studies
5. Summary

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Key drivers

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Cost

Sustainability

Reliability

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What is a microgrid?

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Definition microgrid

A **microgrid** is a local electrical distribution system with **Distributed Energy Resources** operated in a coordinated way so to provide one or more of the following capabilities:

- to manage the site **Energy consumption** and **Demand**
  Peak shaving | Shifting | etc.
- to provide **services** to the **grid** and to the **market**
  Demand response | Ancillary services | etc.
- to increase **resiliency**
  Islanded operation | increase back-up generation availability | etc.
- to integrate **cost-effective energy sources**
  Grid code compliance | Export control | Self-consumption

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Distributed Energy Resources

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Distributed energy resources (DERs) are **electricity-producing resources** or **controllable loads** that are directly connected to a local distribution system.

DERs can include:

- solar panels
- wind turbine
- combined heat and power plants
- electricity storage
- generating set
- electric vehicles
- controllable loads: HVAC, industrial processes, etc.

Source: http://www.ieso.ca/

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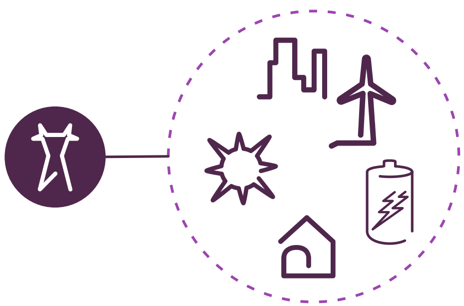
Three types of microgrid

On-site renewables, energy storage and power generation facilities utilized in parallel with grid

Microgrid will generate energy from local sources in the case of a grid outage OR other external event which makes local energy more desirable

Microgrid will generate energy from local source



Grid-tied

Island-able

Off-grid

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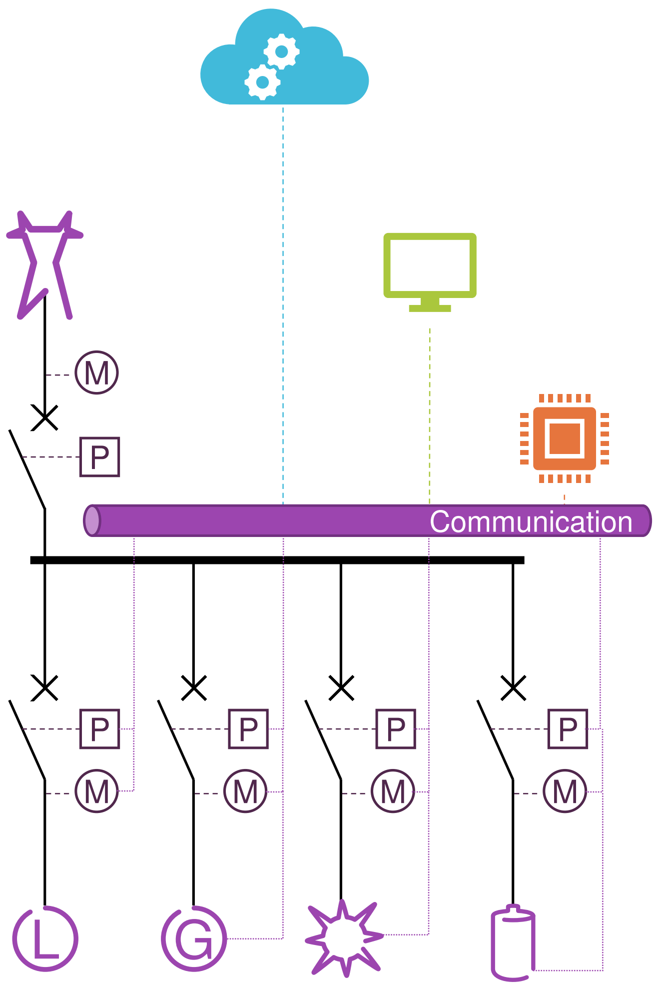
Microgrid Architecture



Cloud services
- Energy Management
- Advanced Algorithm
- Global data collection
- Connection with 3rd parties

Supervision, HMI & Data Management
- Data acquisition
- Alarming, Trending and reporting
- Remote and local interfaces

Microgrid Control
- Real time edge control
- Power Management
- Grid-connection management

Electrical Infrastructure
- Protection schemes
- Power Quality & Metering
- Switchgear and transformer

Distributed Energy Resources
- Electricity generating sources
- Flexible loads

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Something 'New'

Solar PV and Battery Energy Storage System

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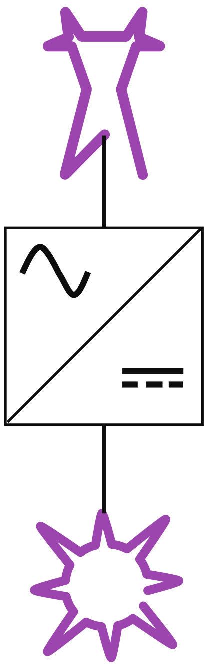
Solar PV Inverter

A solar inverter or PV inverter, is a type of electrical converter which converts the variable **direct current** (DC) output of a photovoltaic (PV) solar panel into a utility frequency **alternating current** (AC) that can be fed into a commercial electrical grid or used by a local, off-grid electrical network.



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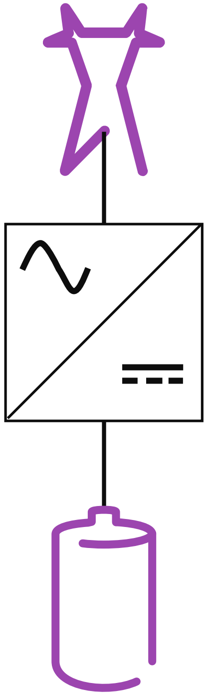
Source: https://en.wikipedia.org/wiki/Solar_inverter

Battery Energy Storage Inverter

Inverters in Battery Energy Storage Inverter are electrical converter which allows the bi-direction conversion of electricity from/to d**irect current**(DC) from/to **alternative current**(AC) so to charge or discharge the batteries into a commercial electrical grid or used by a local, off-grid electrical network.



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Hybrid inverter

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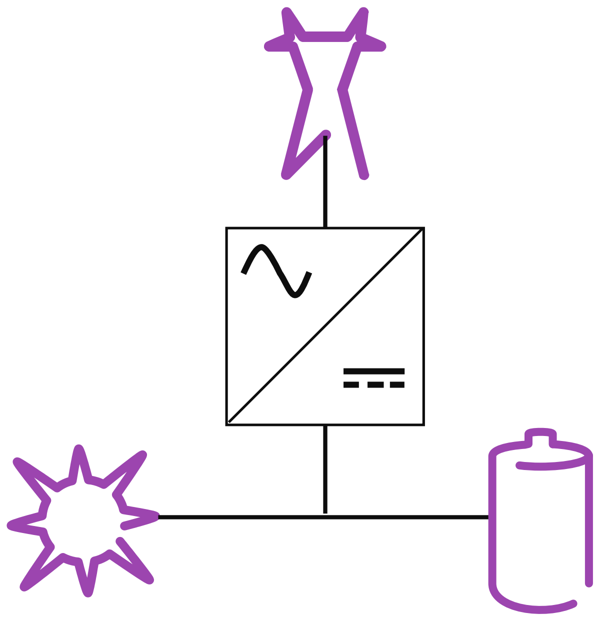
Hybrid inverters allow the connection on the direct current (DC) side of solar panels and batteries so that the battery can be charge directly from the solar panels.



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More on inverters

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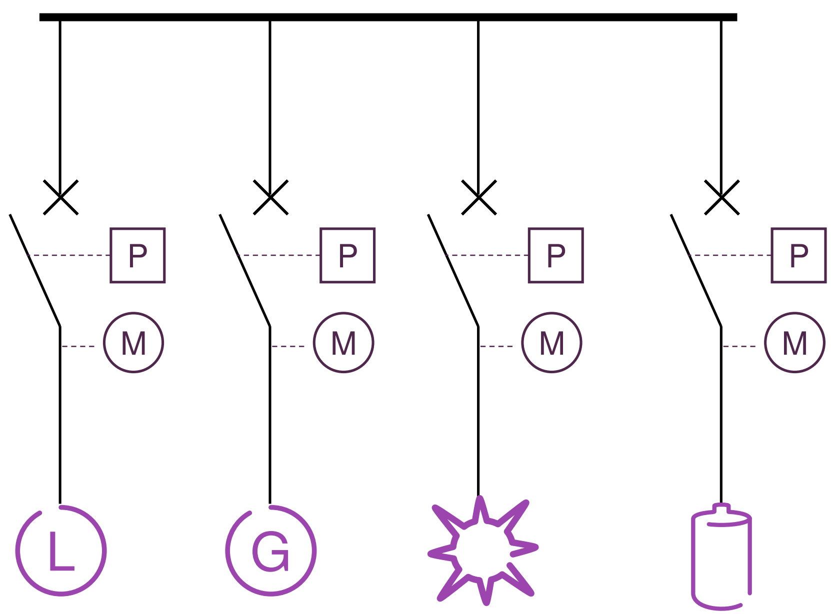
	Grid-tied 'Stiff' inverter	Grid-forming inverter	Virtual Synchronous Generator
Grid-connection	Yes	Yes	Yes
V and f reference	-	Yes	Yes
Parallel operation with other generating units	-	-	Yes



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Frequently Asked Questions Answered

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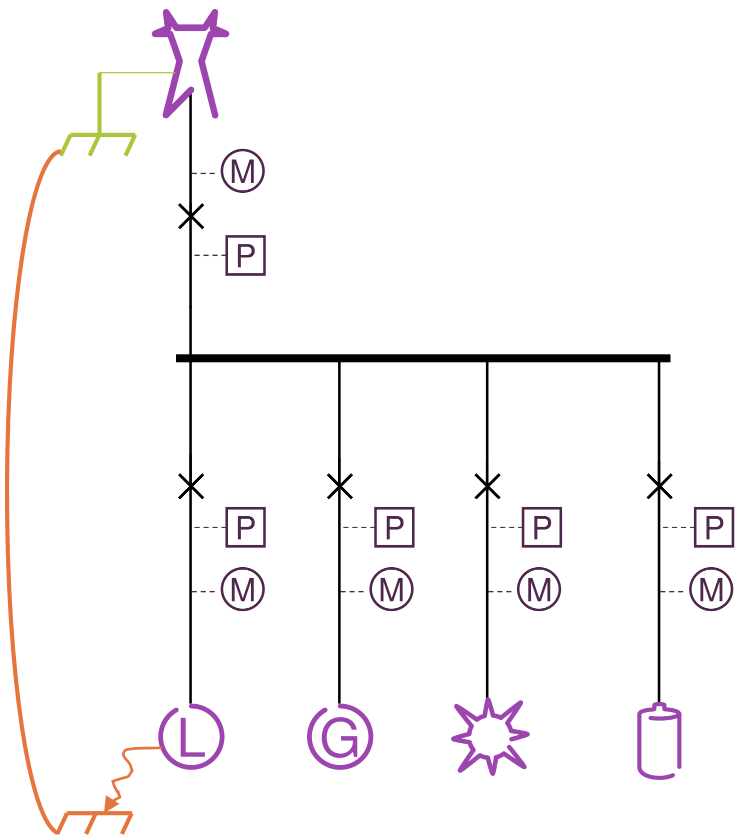
Earthing regime

Grid-tied



- Grid provide Earth reference
- Earth Faults are ‘captured’
- Protection system can detect residual current

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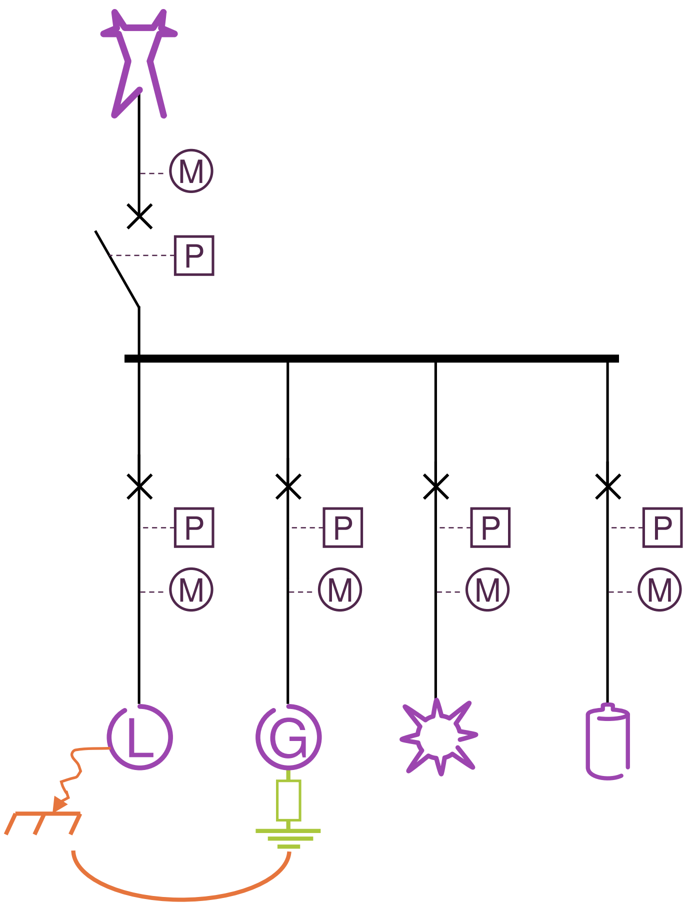
Earthing regime

Islanded Genset back-up



- Earth reference provided through the generator earthing resistor
- Earth Faults are 'captured'
- Protection system can detect residual current

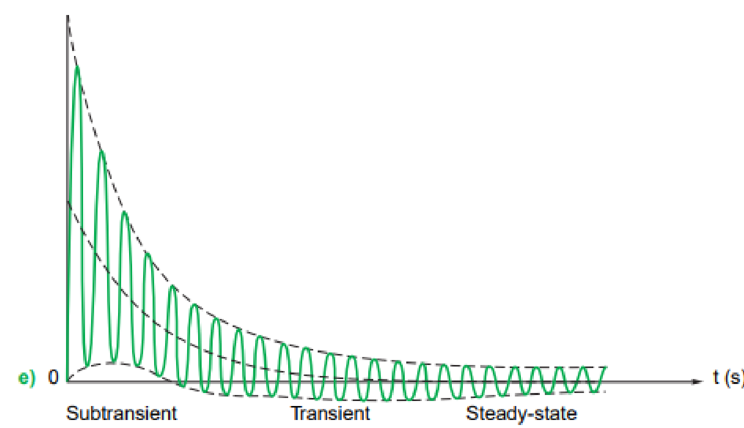


Fig. 10 : Total short-circuit current i_{sc} (e), and contribution of its components:

Source: Cahier technique no. 158 –
Calculation of short-circuit currents – Schneider Electric

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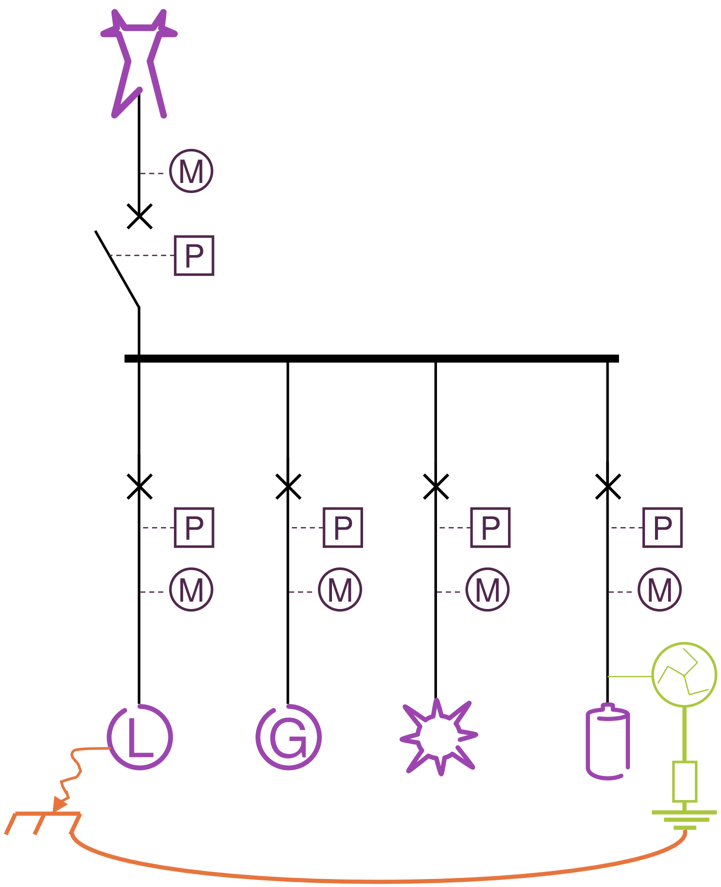
Earthing regime

Islanded BESS



- Earth reference provided through the earthing transformer
- Earth Faults are ‘captured’
- Protection system can detect residual current

$$1.1\ In < If < 2.8In$$

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Control strategy

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Problem

$$C_{ost} = E_{lectricity\ consumption} \times P_{rice} - R_{evenue}$$

$$C = E(_{load,\ DER}) \times P(_{demand,\ location\ ,time}) - R(_{time})$$

f(time, weather)

f(time)

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Source: Schneider Electric All Energy Conference 2018 presentation

What does this tell us?

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- Need to predict and forecast the future.
- Need to use cost effective generation.
- Need to optimise the use of DER.
- Need to be able to access the potential remaining value.

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Source: Schneider Electric All Energy Conference 2018 presentation

Classic control

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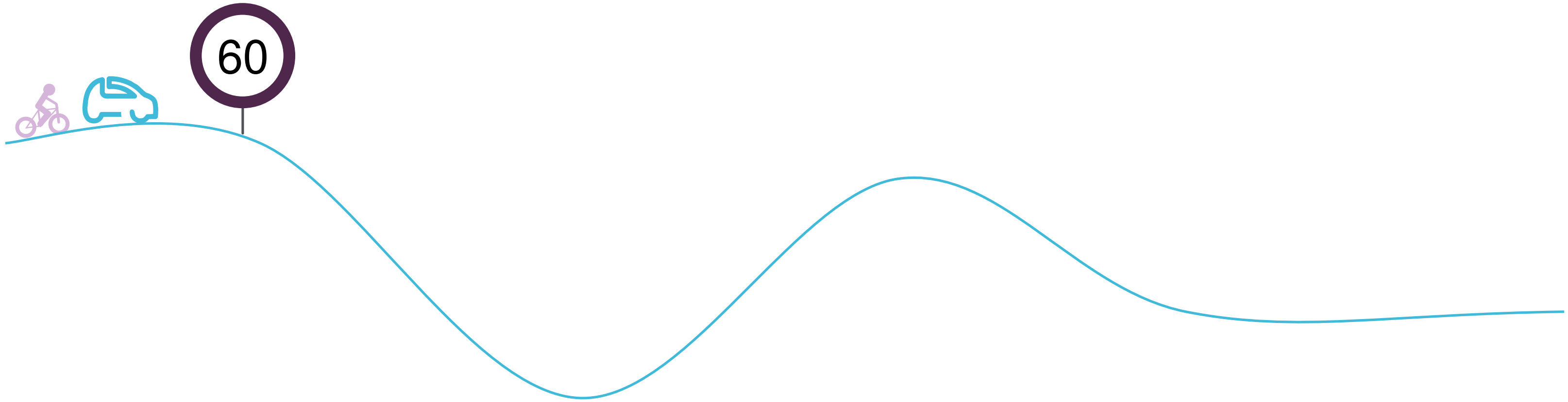

Assumptions

- Car drive at a constant speed.
- Cyclist is subject to gravity.
- Cyclist cannot overtake the car.
- Terrain between start and finish is known.

Constraints

- Cyclist want to maintain a safe distance with the car.
- Cyclist does not want to stop.
- Bicycle freewheels above a certain hub speed.

Source: Schneider Electric All Energy Conference 2018 presentation

Classic control

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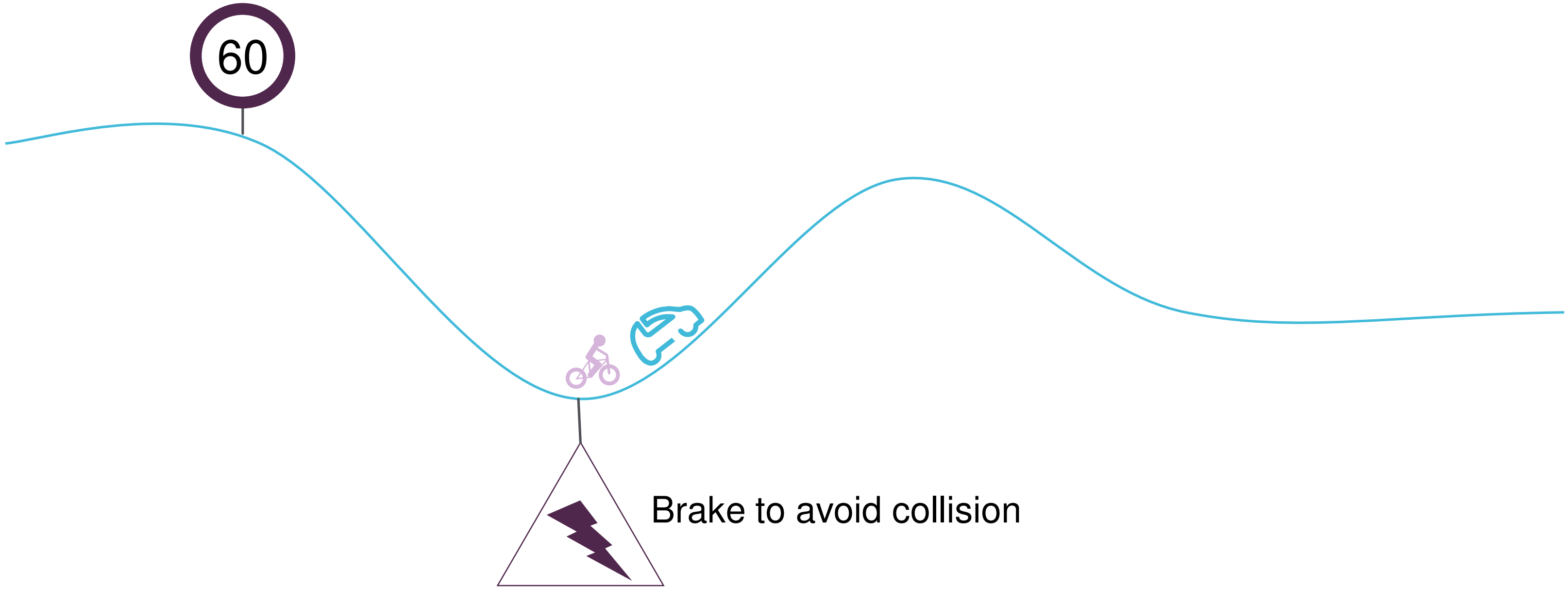

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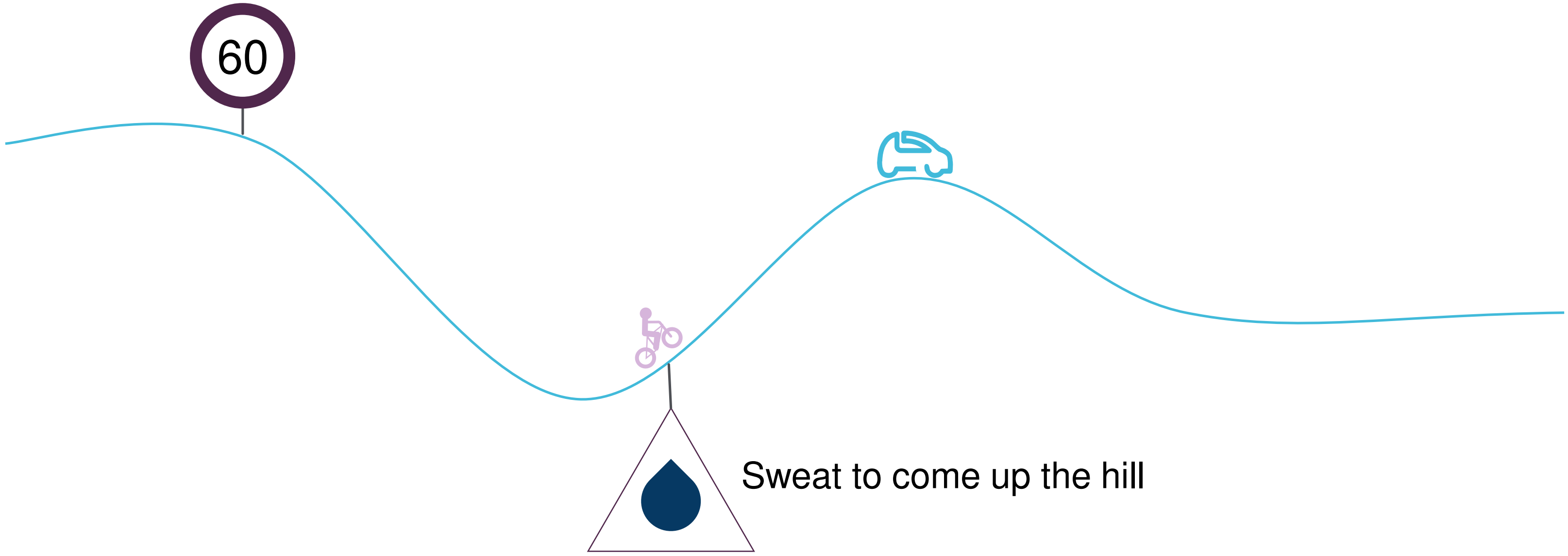
Source: Schneider Electric All Energy Conference 2018 presentation

Classic control



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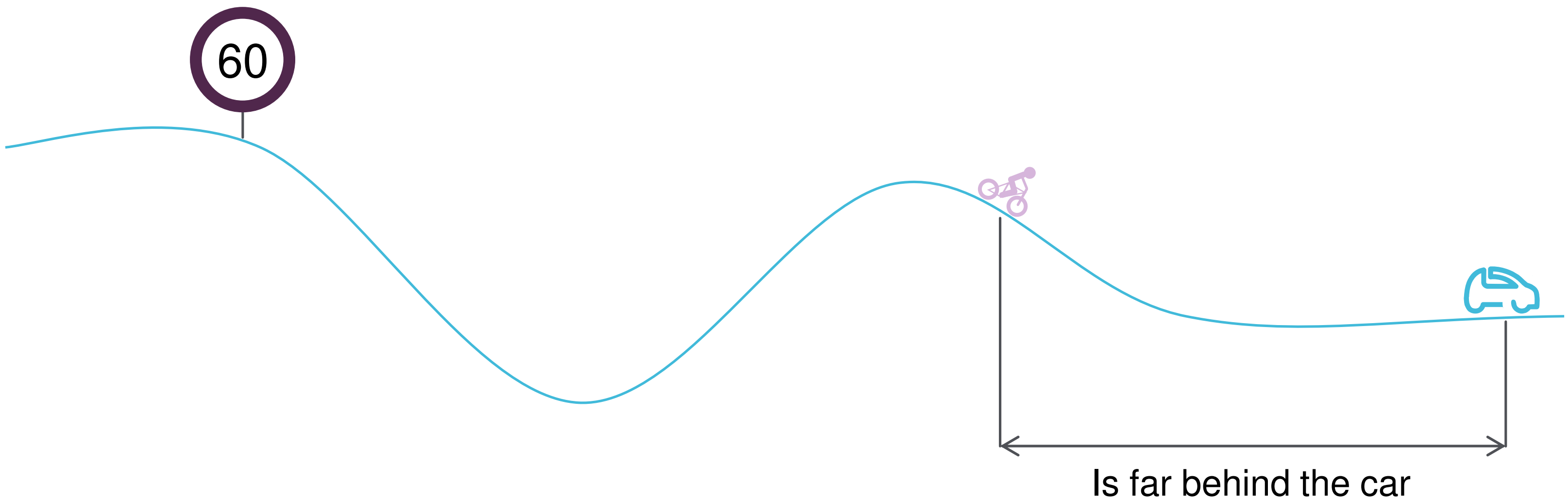
Classic control



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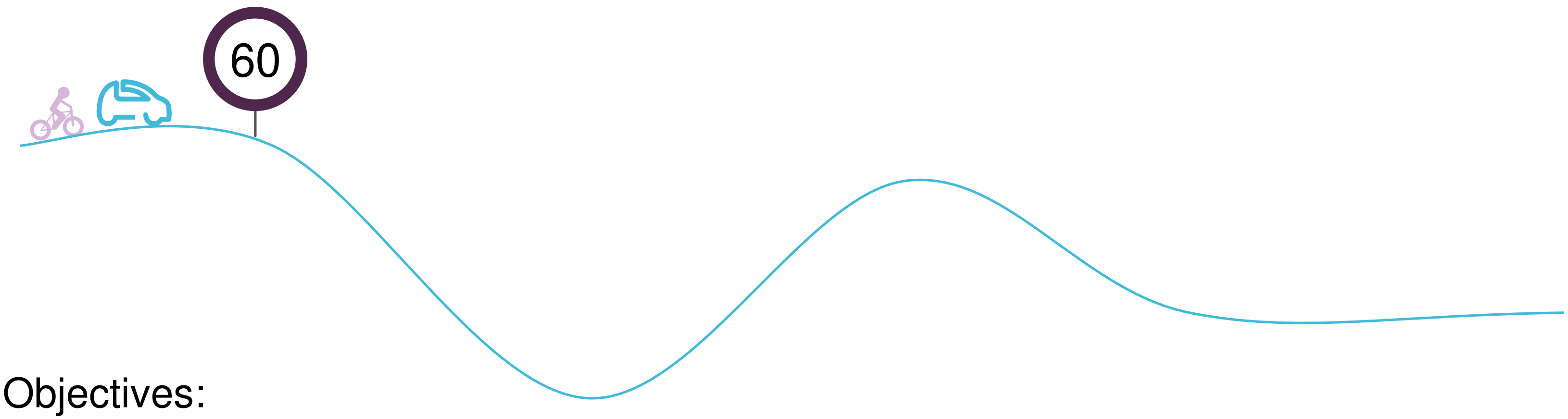
Source: Schneider Electric All Energy Conference 2018 presentation

What can be done differently?



Objectives:
- Minimum amount of effort
- Reduce the travel time

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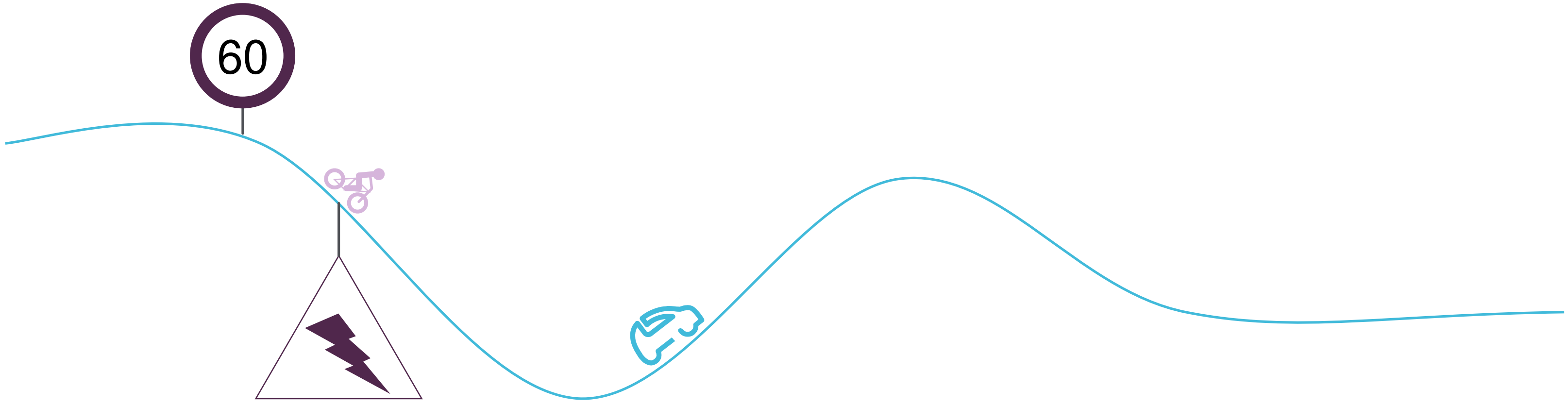
Source: Schneider Electric All Energy Conference 2018 presentation

Predictive control



Brake to save
the potential energy

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Predictive control

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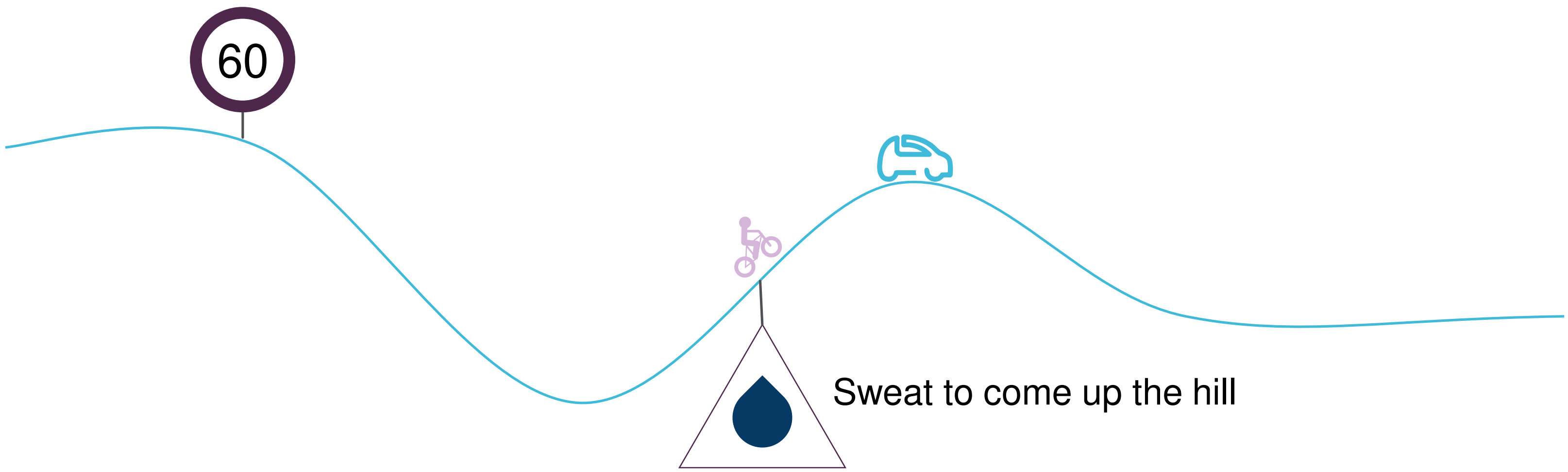

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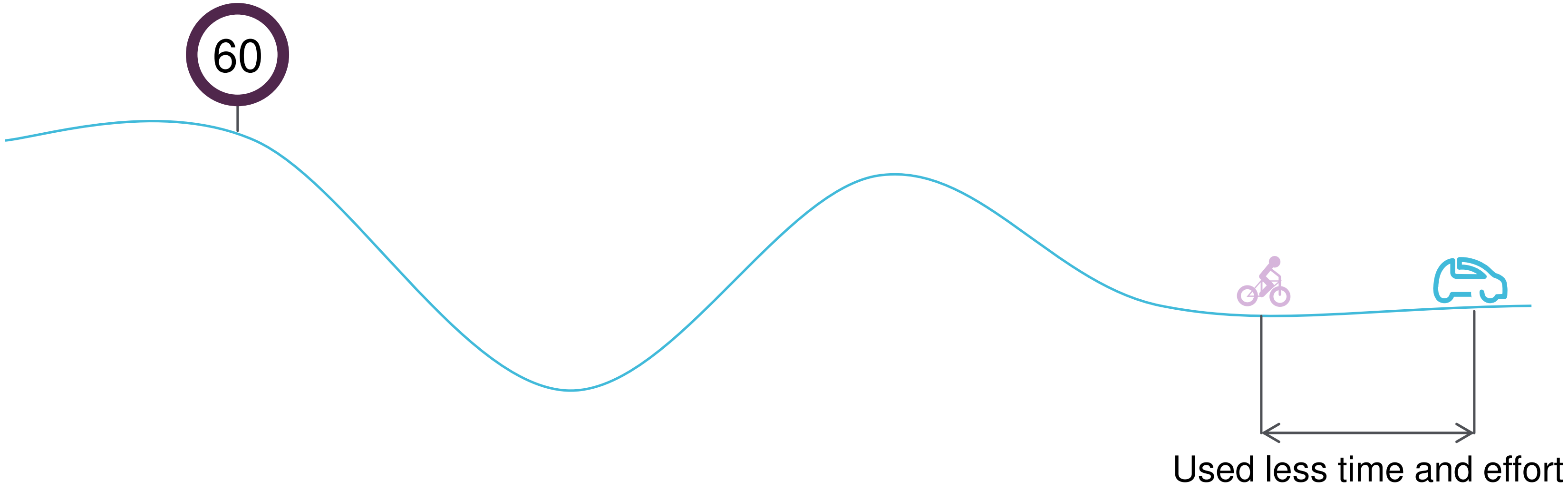
Predictive control



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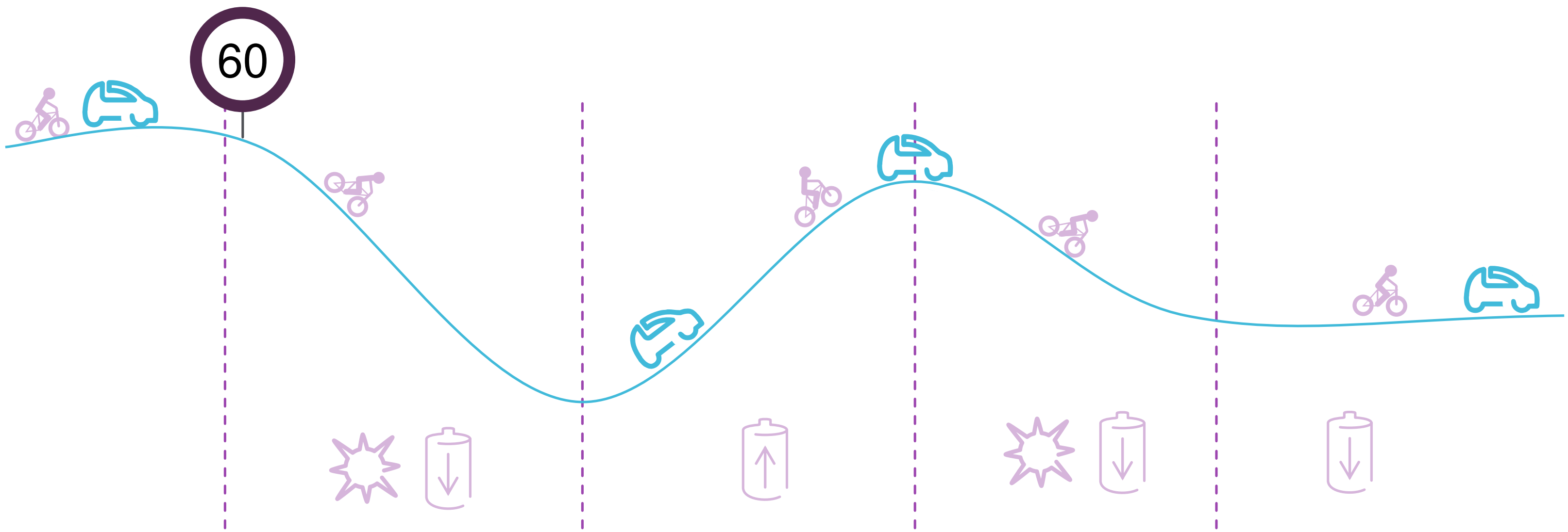
Source: Schneider Electric All Energy Conference 2018 presentation

Predictive control



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Source: Schneider Electric All Energy Conference 2018 presentation

Solution

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Model + Predictions + Objectives

Electricity cost x Generation forecast x Load forecast := Optimised control

Objectives can be:
- Reduce site demand
- Optimise energy usage to lower energy cost

Constraints
- Site operational constraint.
- Equipment operational constraint.

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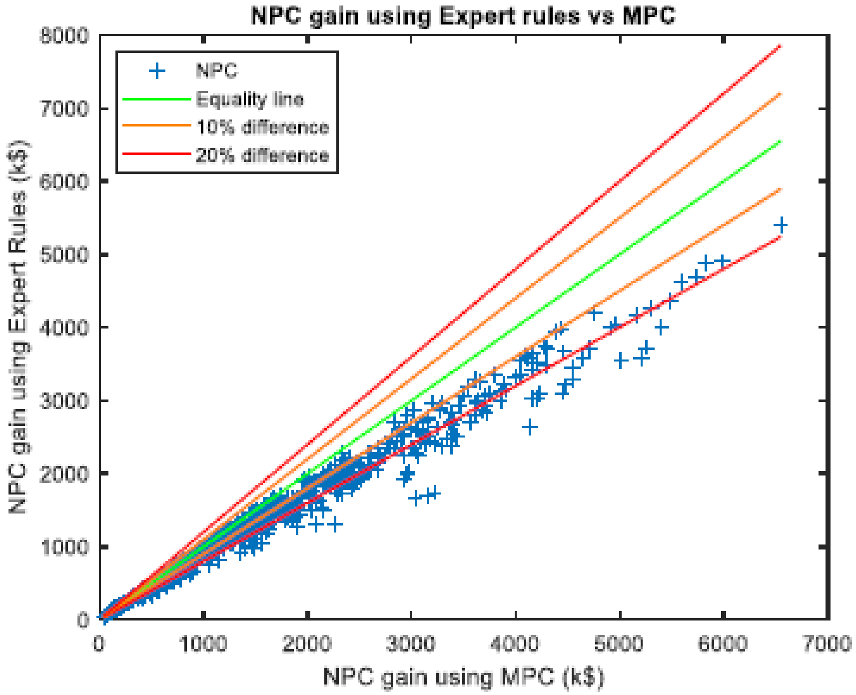
Source: Schneider Electric All Energy Conference 2018 presentation

Benefit of MPC

- Anticipate future: forecasts
- Explicit handling of constraints
- Adapted for multi-variable control applications
- Adapts to changing context
- Increased value of ~10-20% over expert rules



Source: Schneider Electric NPC gain study (17,500 simulations)

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Case study

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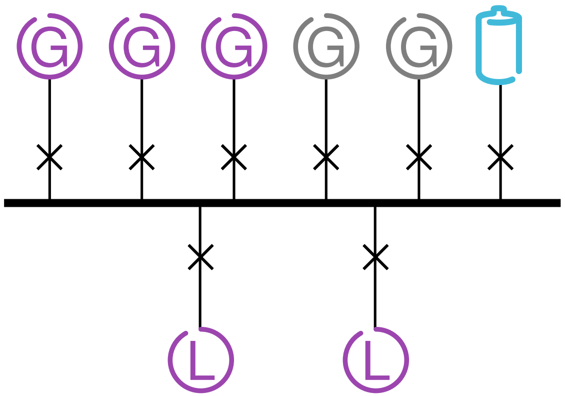
Woodside Goodwyn A platform

Installation of a 1MWh Lion BESS to provide spinning reserve allowing to run with one less gas turbine

Benefits:

- Reduced fuel consumption
- Back-up power supply
- Reduced carbon emissions



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Santos Cooper bassin

Installation of solar PV + Battery Energy Storage System to power the beam pump replacing existing diesel generator.

Benefits:

- Reduced cost of operation
- 100% renewable power

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Onslow Microgrid

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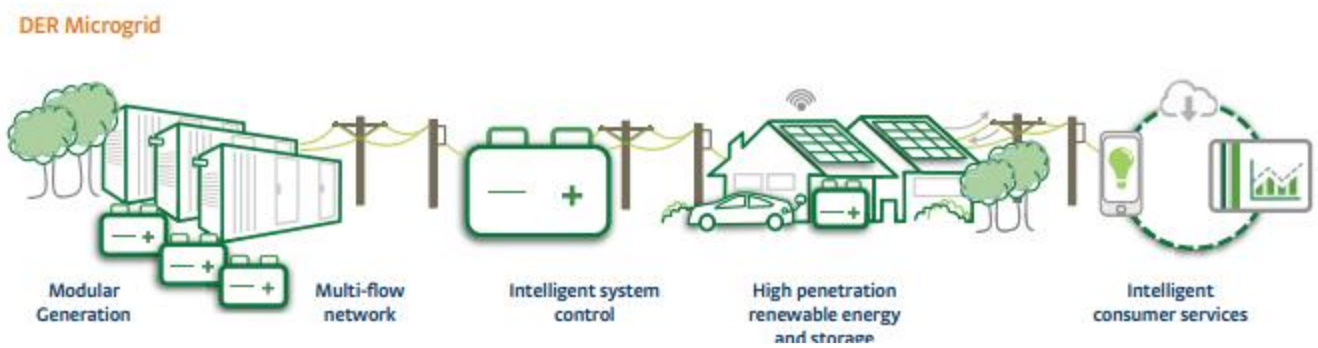
Hybrid microgrid with gas turbine, solar PV and Battery Energy Storage System to supply the township of Onslow.

Benefits:

- Reduce carbon emission
- Lower electricity cost
- Increased supply reliability



Source: Horizon power

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Summary

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3

Type of microgrids

Optimisation
Control
Protection and metering
Electrical Infrastructure
DER

Microgrid Architecture

3

Type of inverters

3

Case studies

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Where next?

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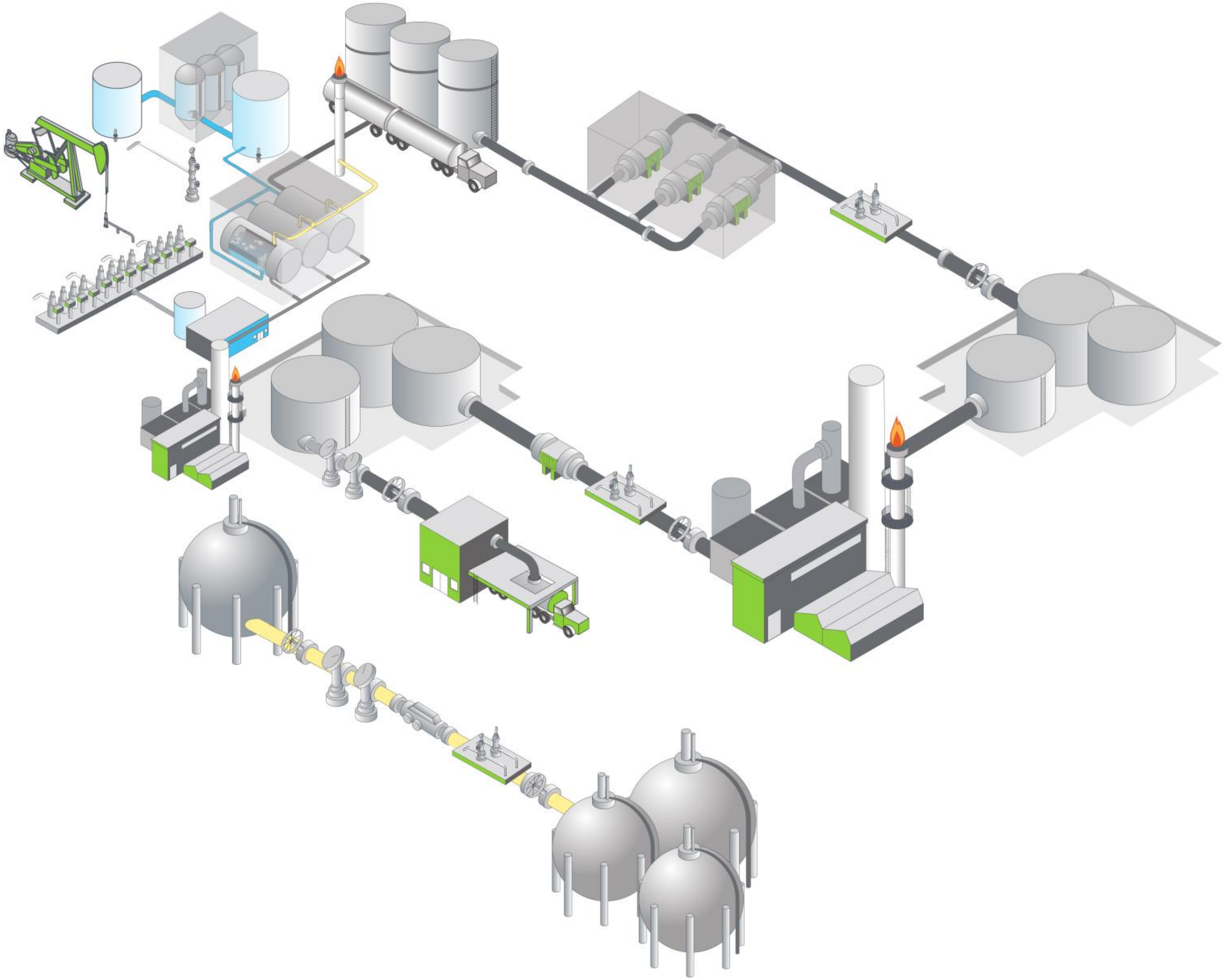

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