UiT The Arctic University of Norway

The nationwide pure PV-EV energy system

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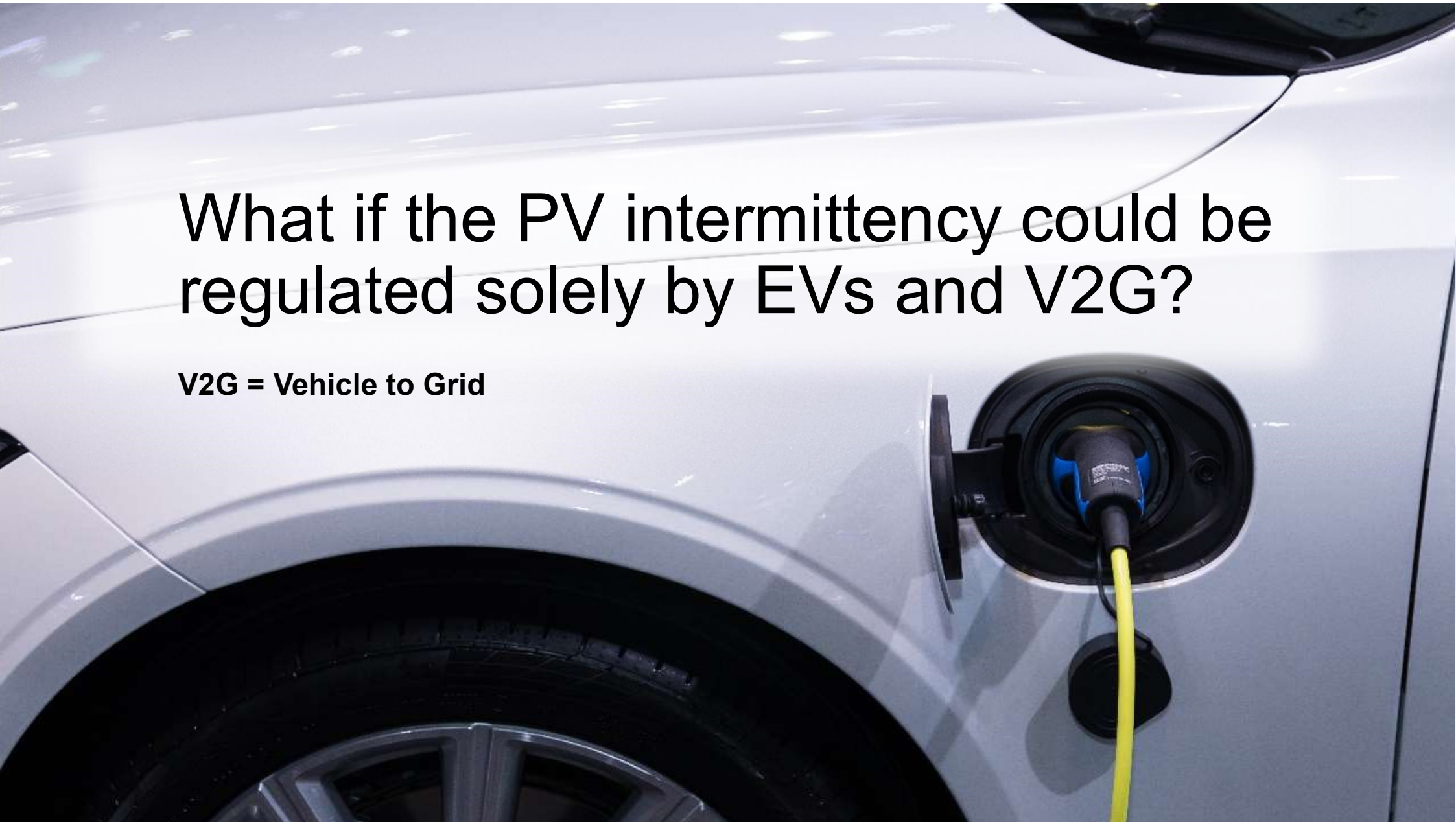
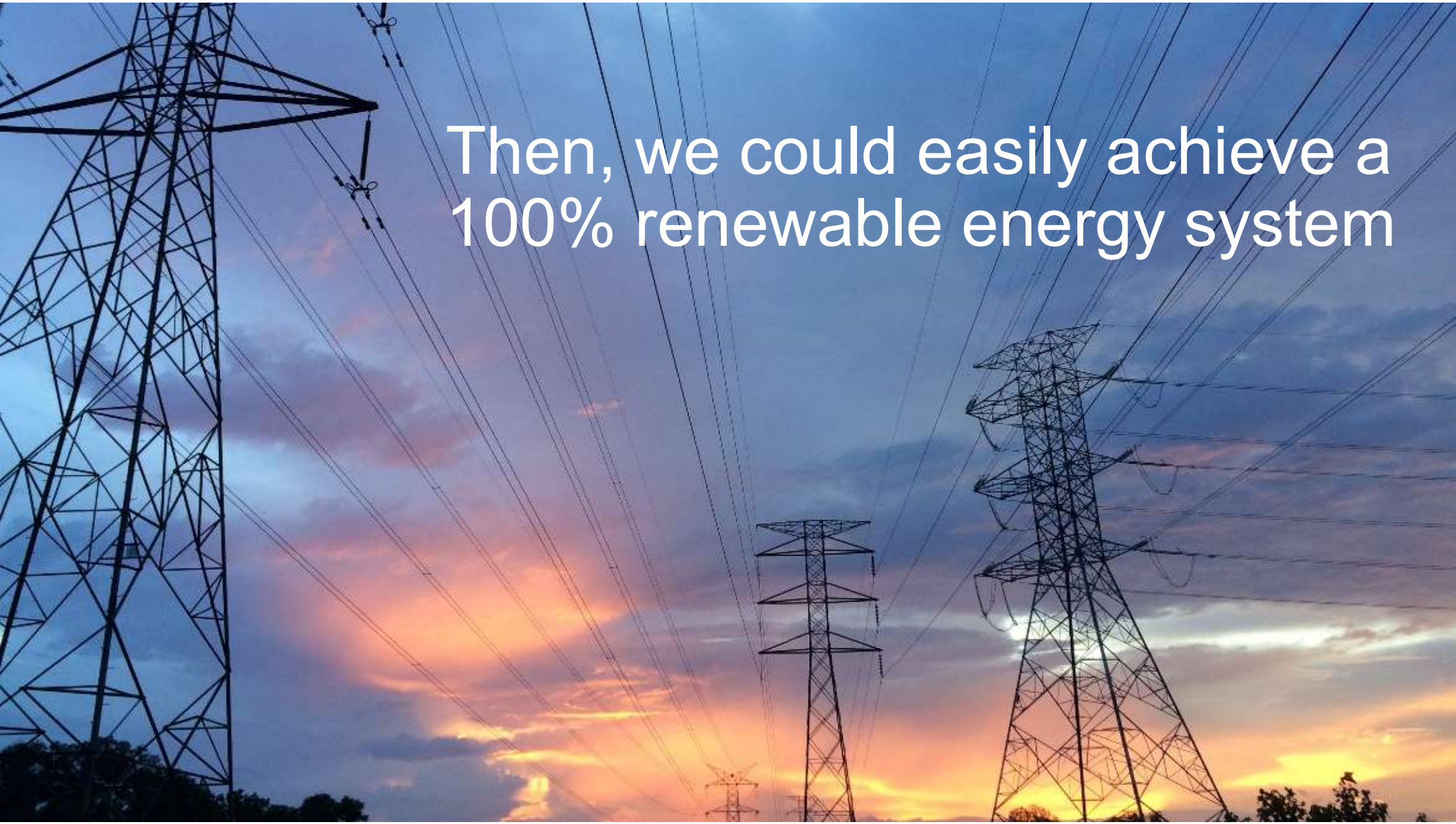
What if we could power an
entire country on solely PV?



What if the PV intermittency could be regulated solely by EVs and V2G?

V2G = Vehicle to Grid


Then, we could easily achieve a
100% renewable energy system

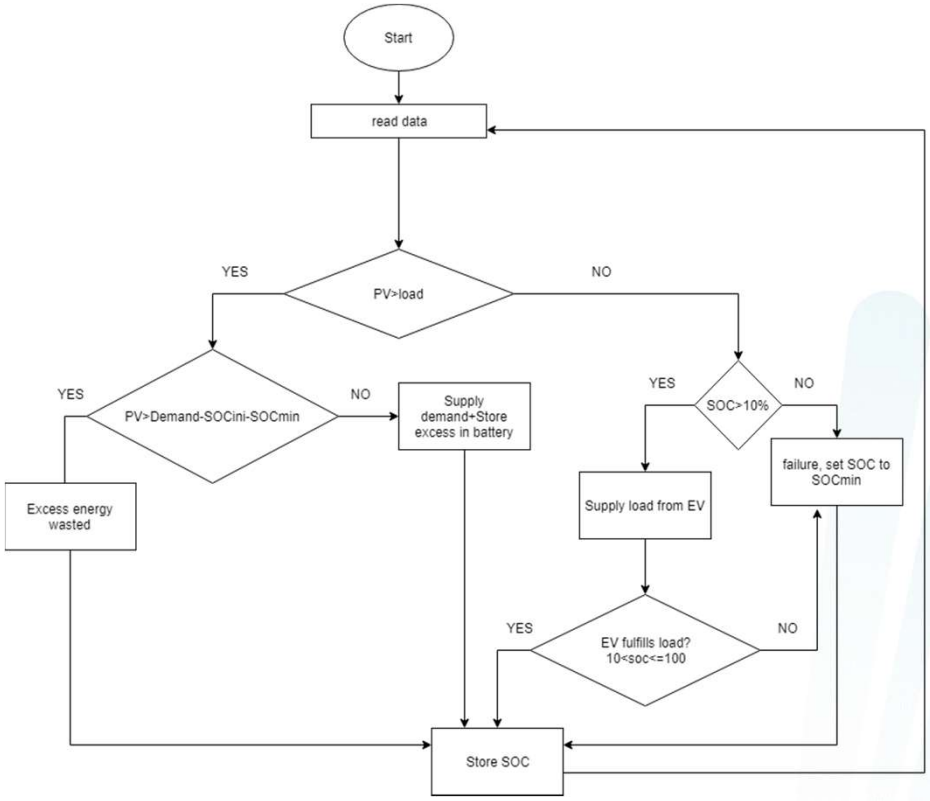
Objectives

1) Reveal the potential and synergy of PV + EVs
2) Demonstrate the feasibility of a nationwide energy system solely reliant on solar energy and EVs

The study use a combination of measured values, simulations, and assumptions

Numerical model

- All road vehicles are EVs
  - 100 kWh batteries
  - 49 km per day
  - 224 Wh per km
- Stationary EVs are V2G connected
- Aggregated photovoltaic (PV) production



The final energy counsumption of Spain can be covered by 56 m^2 of PV per capita

Case study: Spain

Final energy consumption	960 TWh/year
Average PV yield	365 kWh/m^2 and year
Required PV area	2.6 billion m^2
Inhabitants	47 million

Disregarding intermittency

Intermittency & self-reliance

- To what extent the supplied energy can cover the load
- Between 0 % and 100%
- In this study: hourly resolution

Self-reliance using only PV and 1h resolution

Case	PV area per capita	Self-reliance
Only PV	56 m^2	37%

Self-reliance using PV + EVs and 1h resolution

Case	PV area per capita	Self-reliance
Only PV	56 m^2	37%
PV + balancing with EV batteries	56 m^2	93%

100% self-reliance with PV + EVs and 1h resolution

Case	PV area per capita	Self-reliance
Only PV	56 m^2	37%
PV + balancing with EV batteries	56 m^2	93%
PV + balancing with EV batteries	73 m^2	100%

Still 99.5% with EV battery size reduced from 100 kWh to 50 kWh

100% self-reliance in Spain is achiveable!

- Daytime
  - PV energy used directly
  - Surplus PV energy stored in EVs
- Nightime and when cloudy
  - Energy from EV batteries, using V2G
- 3.45 billion m^2 of PV (73 m^2 per capita)
- 29 million EVs

Further work

What if we also include wind and hydro power?

What percentage EVs is needed?

What V2G connection power is needed?

What is the social acceptance?

What are the cost benefits?

Study the same premises in other countries

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The pure PV-EV energy system – A conceptual study of a nationwide energy system based solely on photovoltaics and electric vehicles

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