



**International Partnership for the Hydrogen Economy (IPHE)**  
*Steering committee meeting*

**Emanuele Taibi**

**Hamburg, 27 April 2017**

# OVERVIEW

## MANDATE

To promote the widespread adoption and sustainable use of **all forms of renewable energy** worldwide

## OBJECTIVE

To serve as a **network hub**, an **advisory resource** and an **authoritative, unified, global voice** for renewable energy

## SCOPE

All renewable energy sources produced in a **sustainable manner**



BIOENERGY



GEOTHERMAL  
ENERGY



HYDROPOWER



OCEAN  
ENERGY

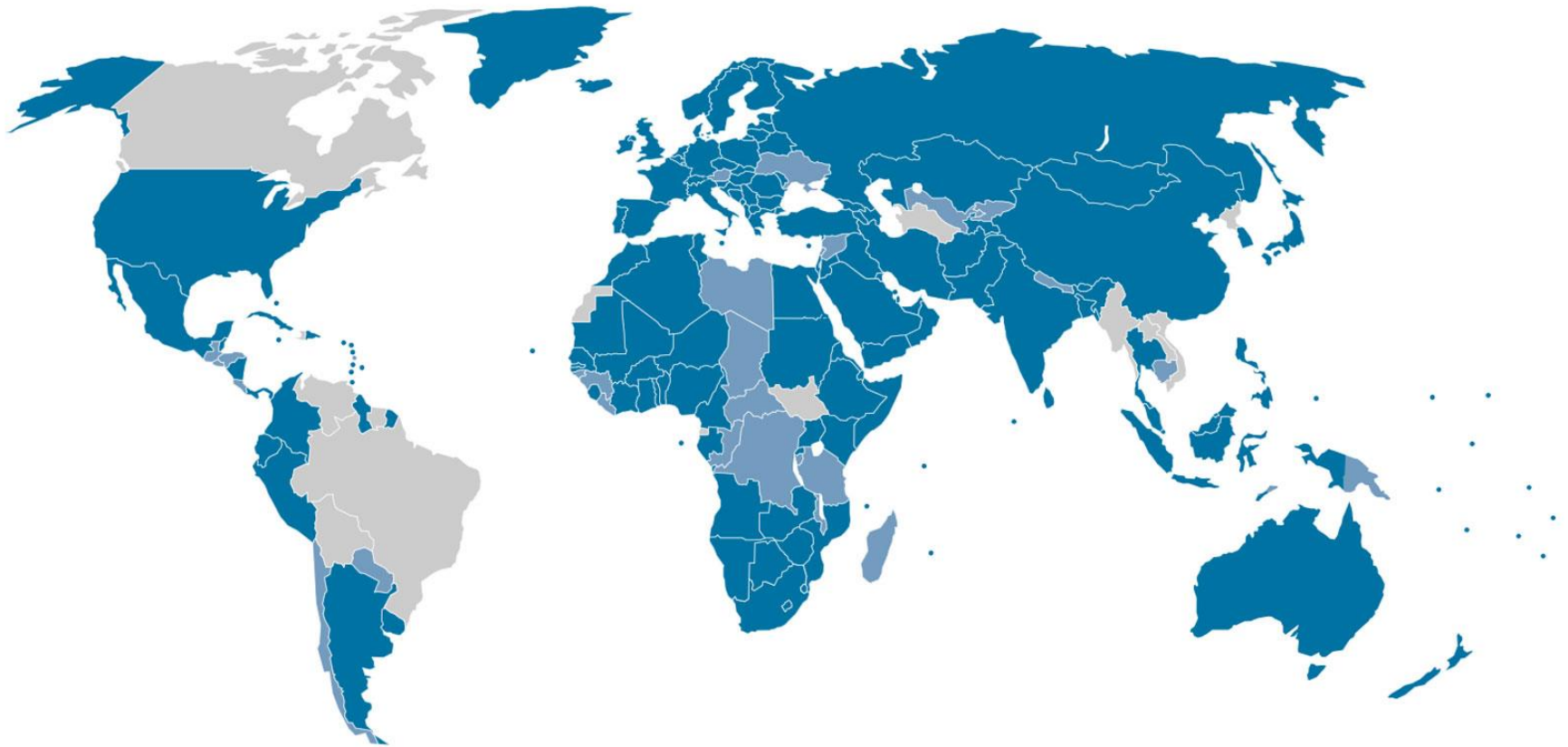


SOLAR  
ENERGY



WIND  
ENERGY

# MEMBERSHIP



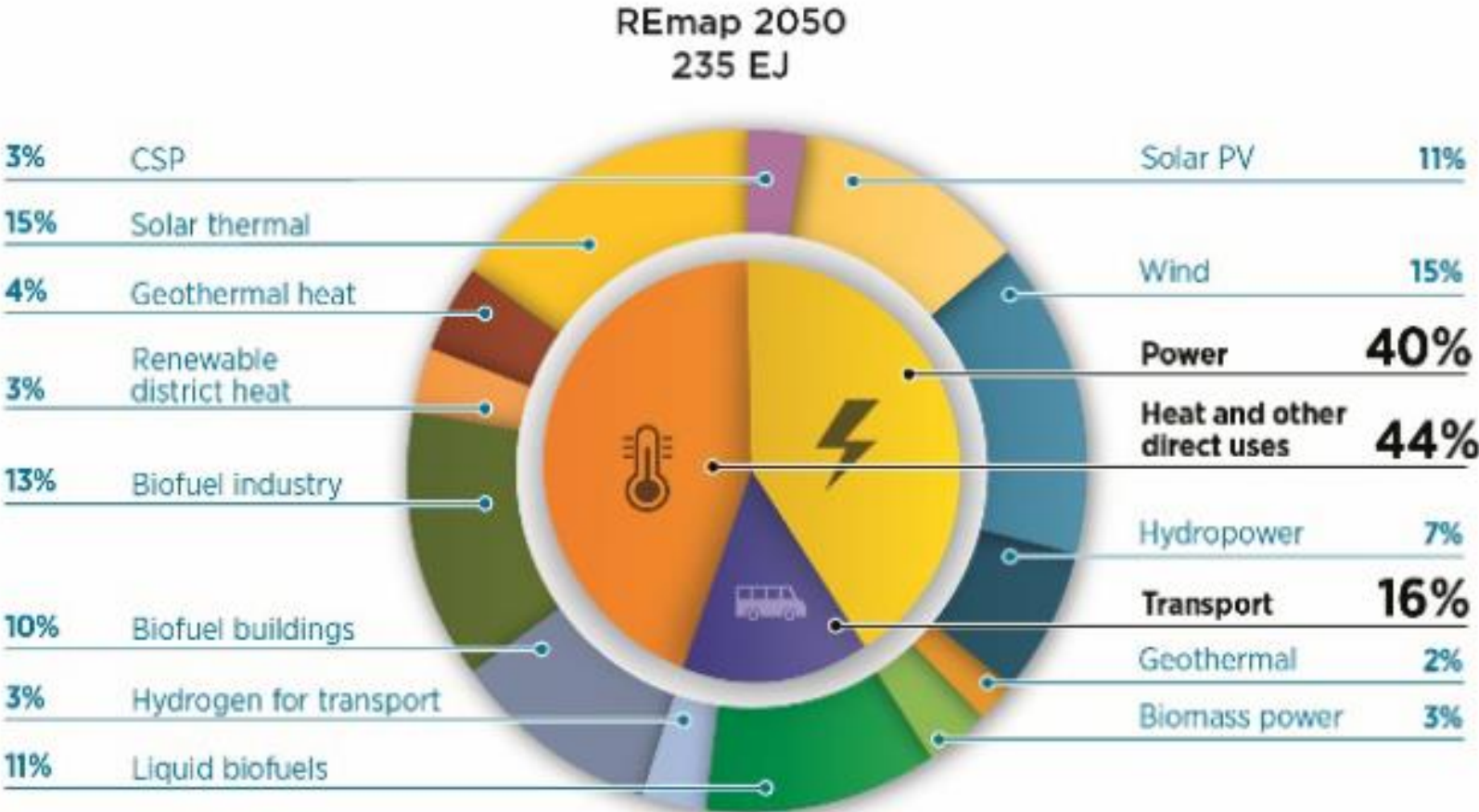
 **150 Members**

 **30 States in Accession**

# Final renewable energy use by sector and technology by 2050 in IRENA's REmap

Renewable energy use in TFECC is four times higher in 2050 than today

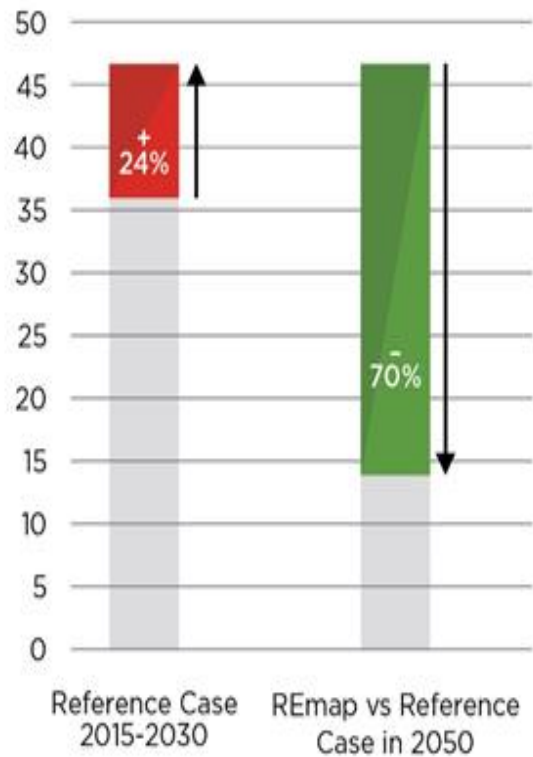
Renewables used for power and heat will both make up around 40% of consumption each, with transport around 20%



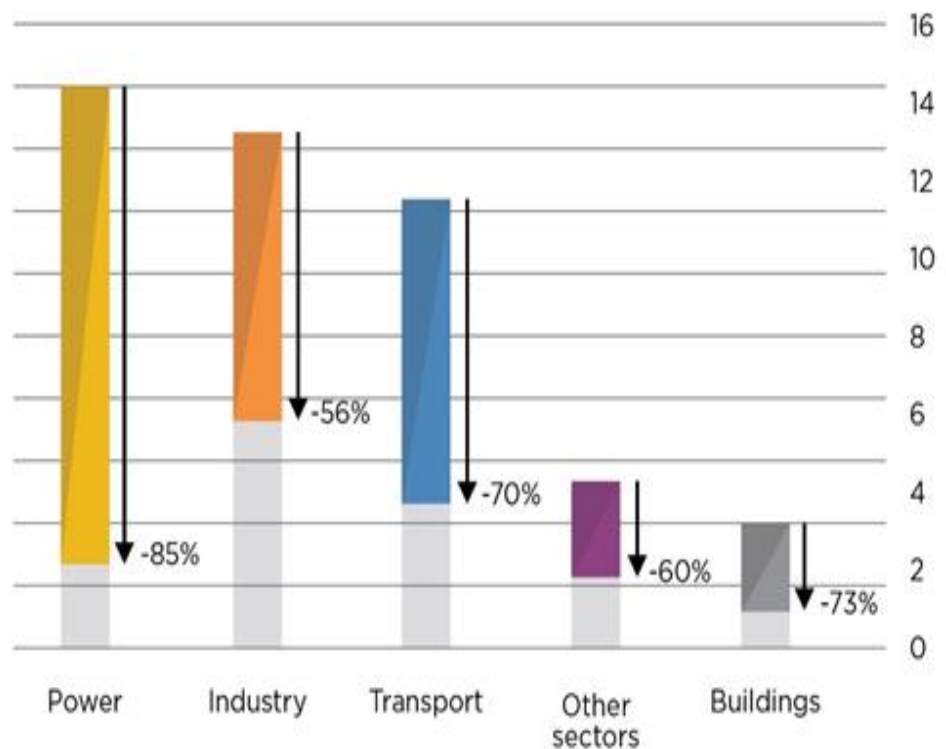
Source: Chapter 3 of Perspectives for the energy transition – investment needs for a low-carbon energy system ©IRENA 2017

# Development in CO<sub>2</sub> emissions by sector

Total direct CO<sub>2</sub> emissions (Gt CO<sub>2</sub>/yr)



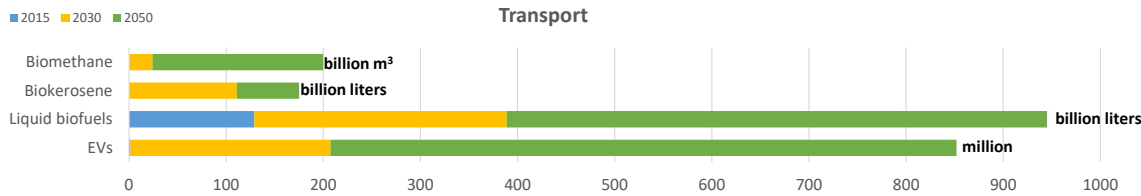
Reductions in 2050 compared to Reference Case



By 2050, total energy and process related CO<sub>2</sub> emissions will need to decrease to below 15 Gt CO<sub>2</sub> emissions from the power and buildings sectors will be almost eliminated.

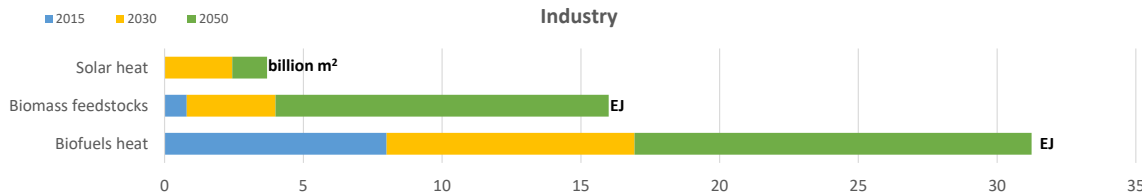
Industry and transport would be the main sources of emissions in 2050.

# The end-use sectors transition: untapped area



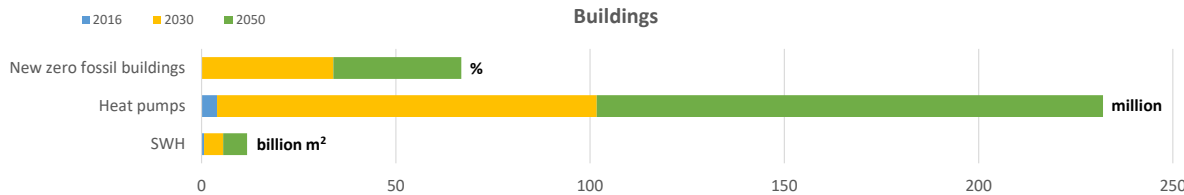
## Transport

- Will traditional car makers able to catch up?
- Significant biofuel trade
- Materials needs (e.g. rare earth for EVs)



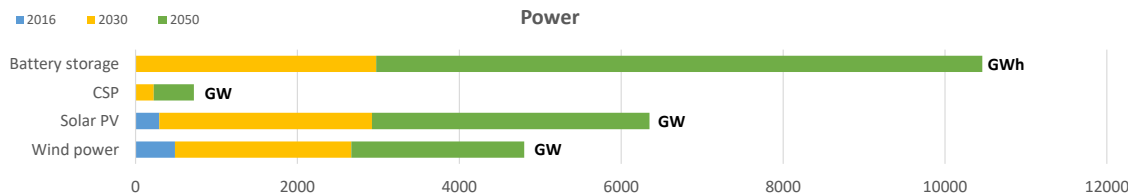
## Industry

- Industry is the most challenging sector



## Buildings

- Significant acceleration of buildings renovation



## Power

- Growing equipment industries
- Materials needs (e.g. for batteries, inverters)

# Hydrogen's role in decarbonising transport

- ❖ **Transport sector:** Some countries see a potential for hydrogen as a transport fuel. IRENA's REmap analysis estimates that hydrogen may cover close to 10% of the passenger car and freight segment's energy demand by 2050, representing close to 7 EJ.

## TRANSPORT

~20% of all transport energy demand is electric      
  

10 times **more** liquid and gaseous biofuels 

One third of all aviation fuel is advanced biofuel 

# Hydrogen's role in decarbonising passenger road transport

Under REmap, fossil fuels would represent a quarter of sector's total energy use.  
Biofuels would represent a quarter of the total demand.  
Electricity about 44%.  
The remainder 8% would originate from hydrogen.

*Fuel cells*



*Batteries*





# Hydrogen's role in decarbonising road freight

Hydrogen fuel cells represent 20% of the total energy demand of the freight sector in REmap 2050

## *Fuel cells*



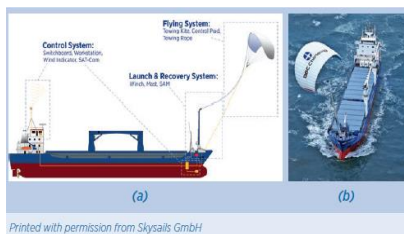
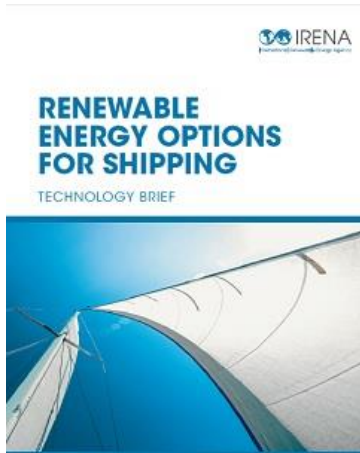
## *Batteries*



Hydrogen can be used in a combustion engine or a fuel cell. A fuel cell of 300 kW size and an applicable battery for long-haul systems would suffice. Durability of fuel cells is important and must reach around 15 000 hrs for long-haul trucks. Currently, fuel cells have durability of around 2 500 hrs.

# Hydrogen's role in decarbonising shipping

## Wind



*Printed with permission from Greenheart Project, B9 Shipping, Dykstra Naval Architects and Seagate*



*Printed with permission, courtesy of Econ Marine, OCIUS Technology Ltd and NYK Ltd*

## Hydrogen fuel cells

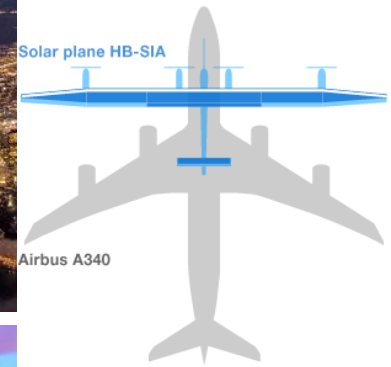


# Hydrogen's role in decarbonising aviation

## Hydrogen



## Solar + batteries



SOURCE: SolarImpulse



# Hydrogen's role in decarbonising industry

- ❖ **Industry sector:** Under REmap, renewables-based hydrogen accounts for around 1% of all industrial energy demand by 2050, or 0.9 EJ. Mainly to **replace gas in the process of direct reduction of iron ore**, and for the **production of ammonia and methanol**

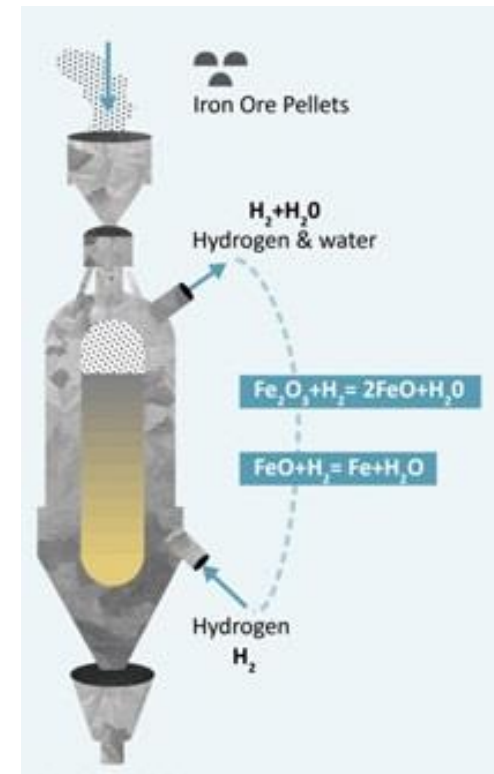
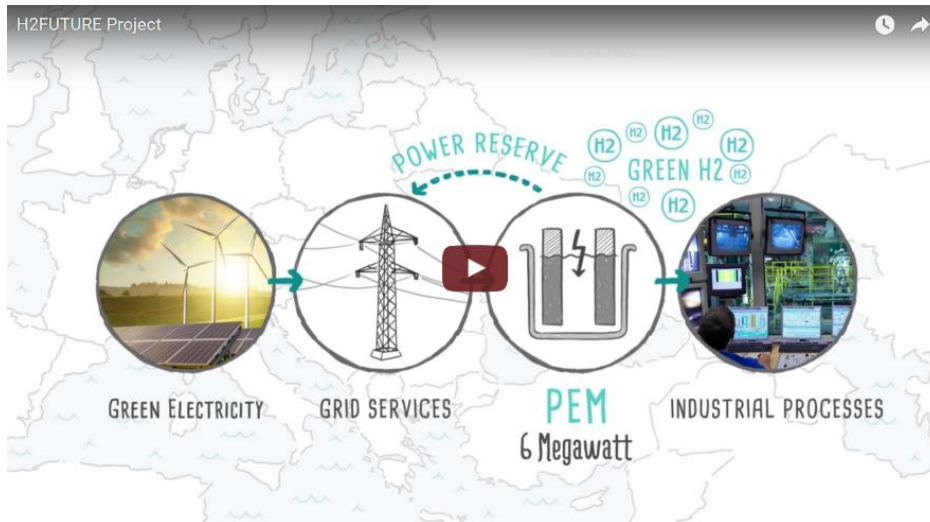
## INDUSTRY

Petrochemicals - 25% bioplastics and biofibres - from <4% today 🚰

Cement - 35% new cement types (2.1 Gt) 🏠

Iron and steel - H<sub>2</sub>-based processes, more DRI, relocation - 200 iron plants affected 🏭

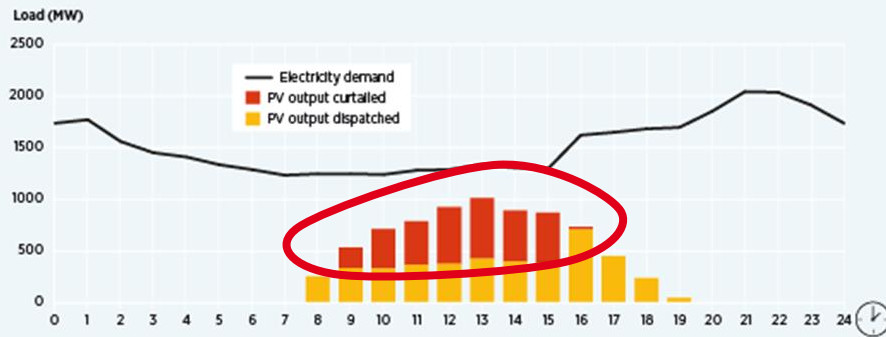
Annually, 1.4 Gt industrial CO<sub>2</sub> emissions are captured 🌍



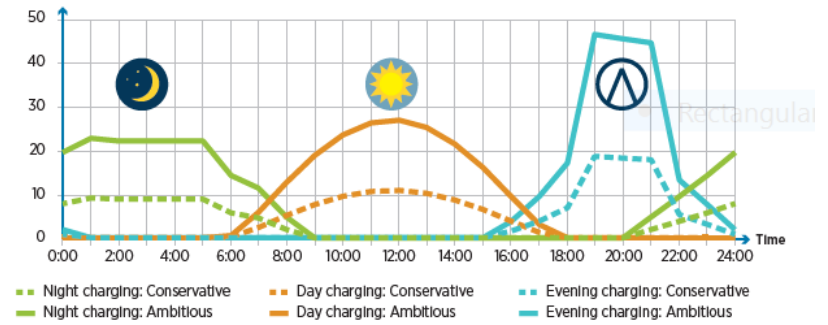
# Hydrogen's role in decarbonising the power sector

## ❖ Power systems: Power-to-gas -> avoid curtailment due to operational constraints

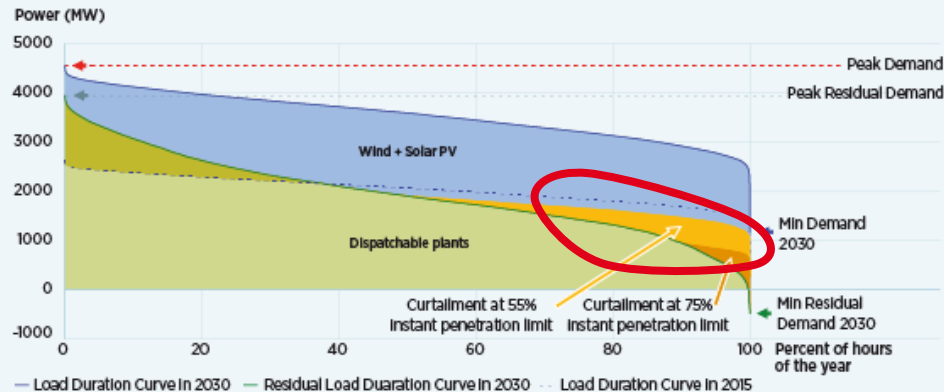
Roadmap shows that PV curtailment is a potential issue and identifies specific measures to boost RE share.



EV charging demand (MW)



REmap analysis provides insight on integrating higher shares of PV and wind.



### EVENING PEAK

- EVs charged at home as people return from work
- Likely charging pattern with no policy intervention
- Reduces system reliability by adding to existing evening peak demand
- Should be discouraged with time of use pricing and availability of public charging stations



### NIGHTTIME

- Requires pricing signals and smart grid technologies to delay / prolong charging away from evening peak
- Better option for home charging
- Opportunity for vehicle-to-grid in the future, with EVs providing remunerated services to the grid



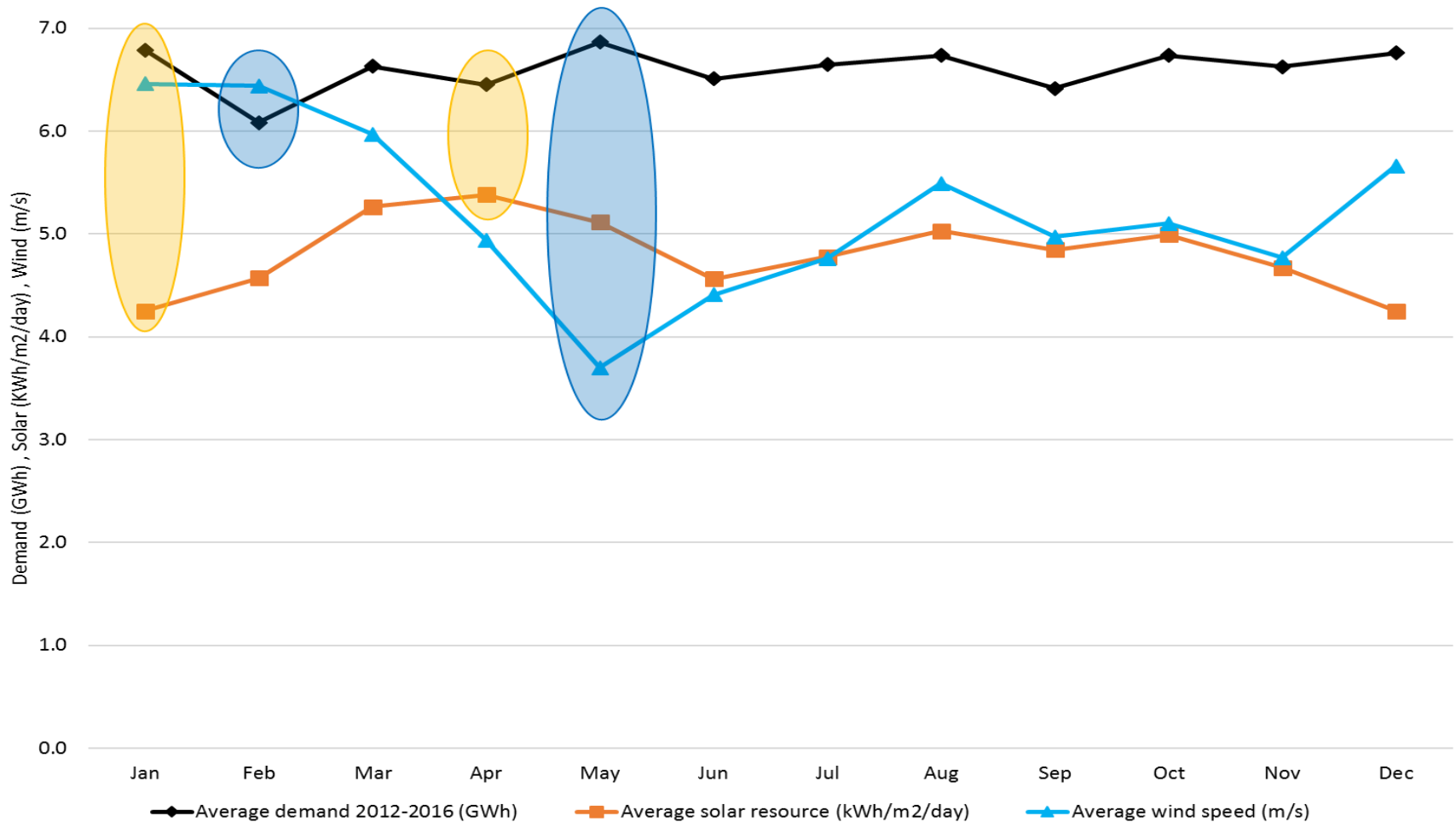
### DAYTIME

- Maximizes RE share in EV charging: 58-76%
- Significantly reduces RE curtailment from 14.5% to 9.3%
- Supports deployment of additional 12 MW of PV
- Requires investment in public charging infrastructure



# Hydrogen's role in decarbonising the power sector

## ❖ Power systems: Power-to-gas -> seasonal storage



# Mission Innovation

## Innovation challenge on solar fuels

Mission Innovation launched at COP21 in November 2015 in Paris: 22 countries and the European Union targeted to double their public clean energy R&D investment over five years

Includes an innovation challenge on **Converting Sunlight into Storable Solar Fuels**

Ongoing discussion to focus the challenge on stimulating international cooperation in the following R&D areas:

- Catalyst development for water splitting and CO<sub>2</sub> reduction (oxygen evolution reaction - OER, hydrogen evolution reaction - HER and CO<sub>2</sub> reduction reaction - CO<sub>2</sub>RR)
- Photoelectrochemical cells - PECs
- Photovoltaic electrolyzers (capable of intermittent operation)
- Thermochemical pathways to solar fuels (using concentrated solar light)
- Design and engineering of solar fuels modules

# Conclusions

- The world needs an energy transformation. We have started the energy transition
- This needs to be accelerated further. Energy efficiency and renewable energy are at the core
- Renewable energy deployment rate needs to increase eight-fold
- Energy efficiency deployment rate needs to increase 1.5 fold
- Immediate action is needed
- More innovation is needed
  - Technology
  - Enabling policy framework and regulations
  - Business models
  - Financing
- This is technically feasible and benefits will exceed costs if the right policies are in place, which include broader economic policies
- Hydrogen can provide significant contribution to the decarbonization of the energy system. In the short term, it faces competition from more affordable and mature alternatives, but in the long terms limited alternatives exist in some sectors.





[www.irena.org](http://www.irena.org)



[www.twitter.com/irena](https://www.twitter.com/irena)



[www.facebook.com/irena.org](https://www.facebook.com/irena.org)

**Emanuele Taibi**

**Power Sector Transformation Strategies**

[ETaibi@irena.org](mailto:ETaibi@irena.org)