Technology development path for carbon-neutral society

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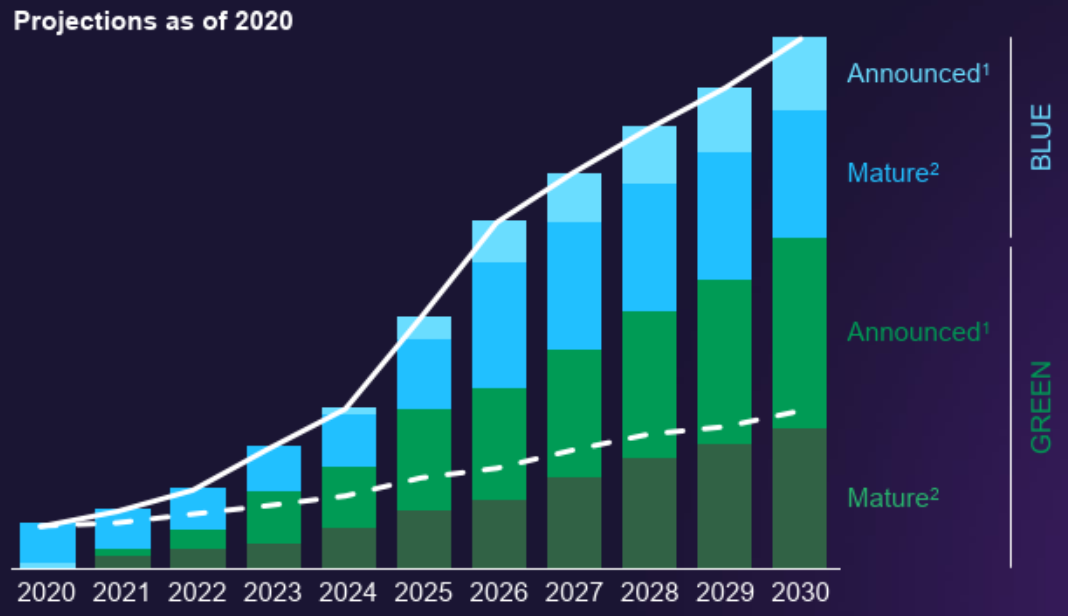
Strong growth in green hydrogen drives cost competitiveness and development

Announced clean hydrogen capacity through 2030

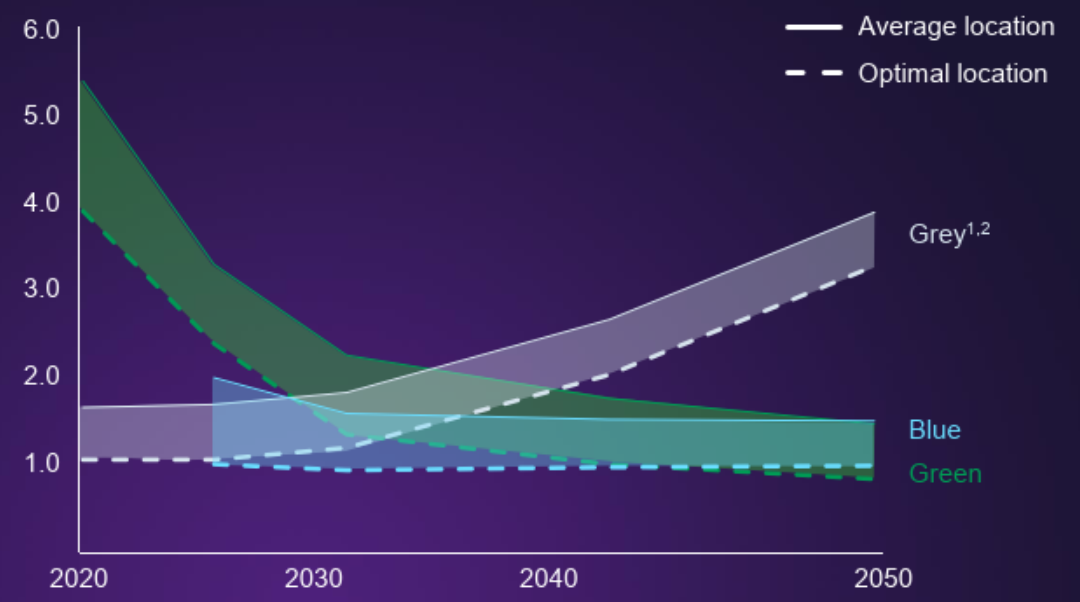
Production capacity
Mt p.a.



1. Includes projects at preliminary studies or at press announcement stage; 2. Includes projects that are at the feasibility study or front-end engineering and design stage or where a final investment decision (FID) has been taken, under construction, commissioned or operational

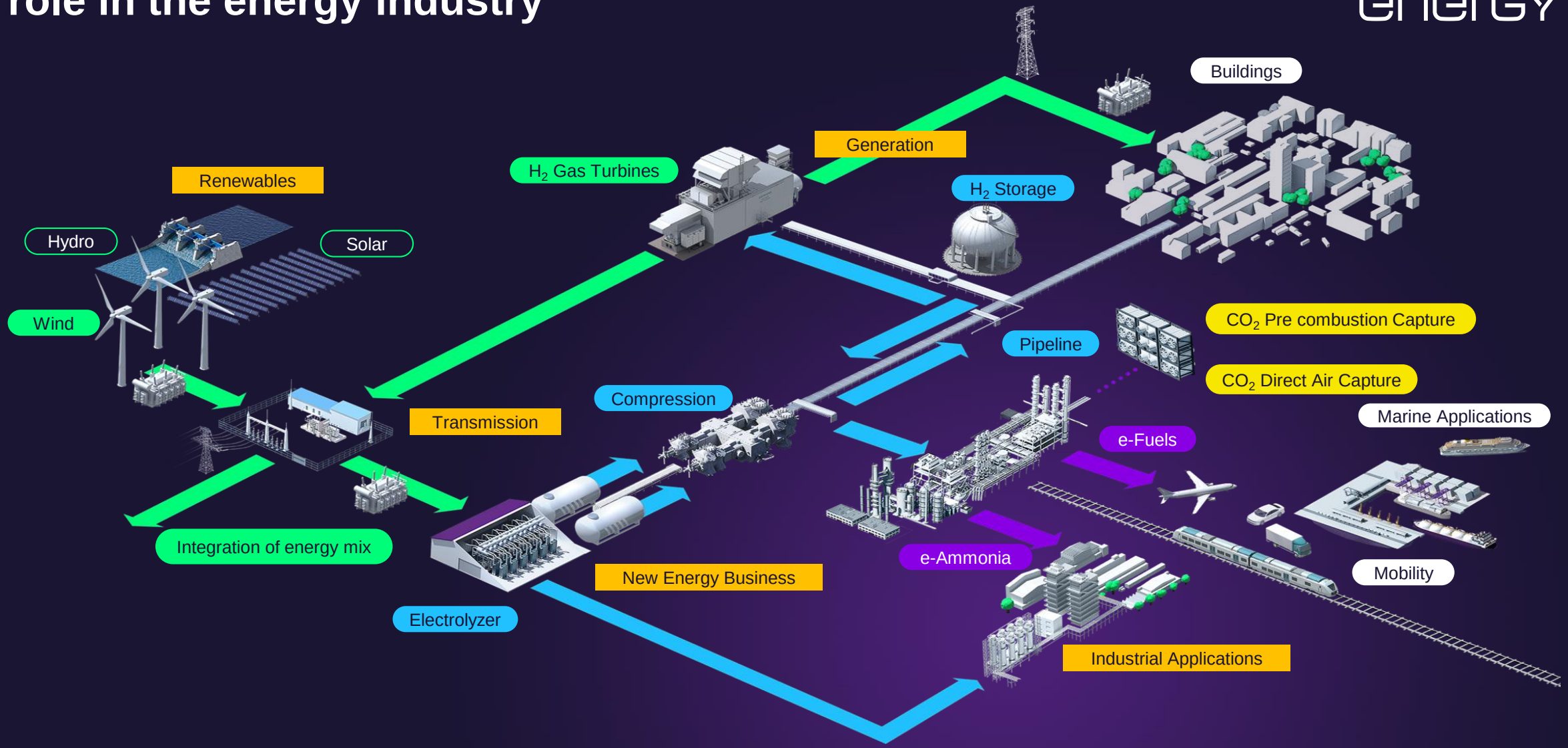
Hydrogen production pathways, including carbon costs

Production cost of hydrogen
USD/kg



Key assumptions: Gas price 2.6–6.8 USD/Mmbtu
Cost USD/Ton CO_2 30 (2020), 50 (2030), 150 (2040) and 300 (2050)
LCOE USD/MWh 25 – 73 (2020), 13 – 37 (2030) and 7 – 25 (2050)

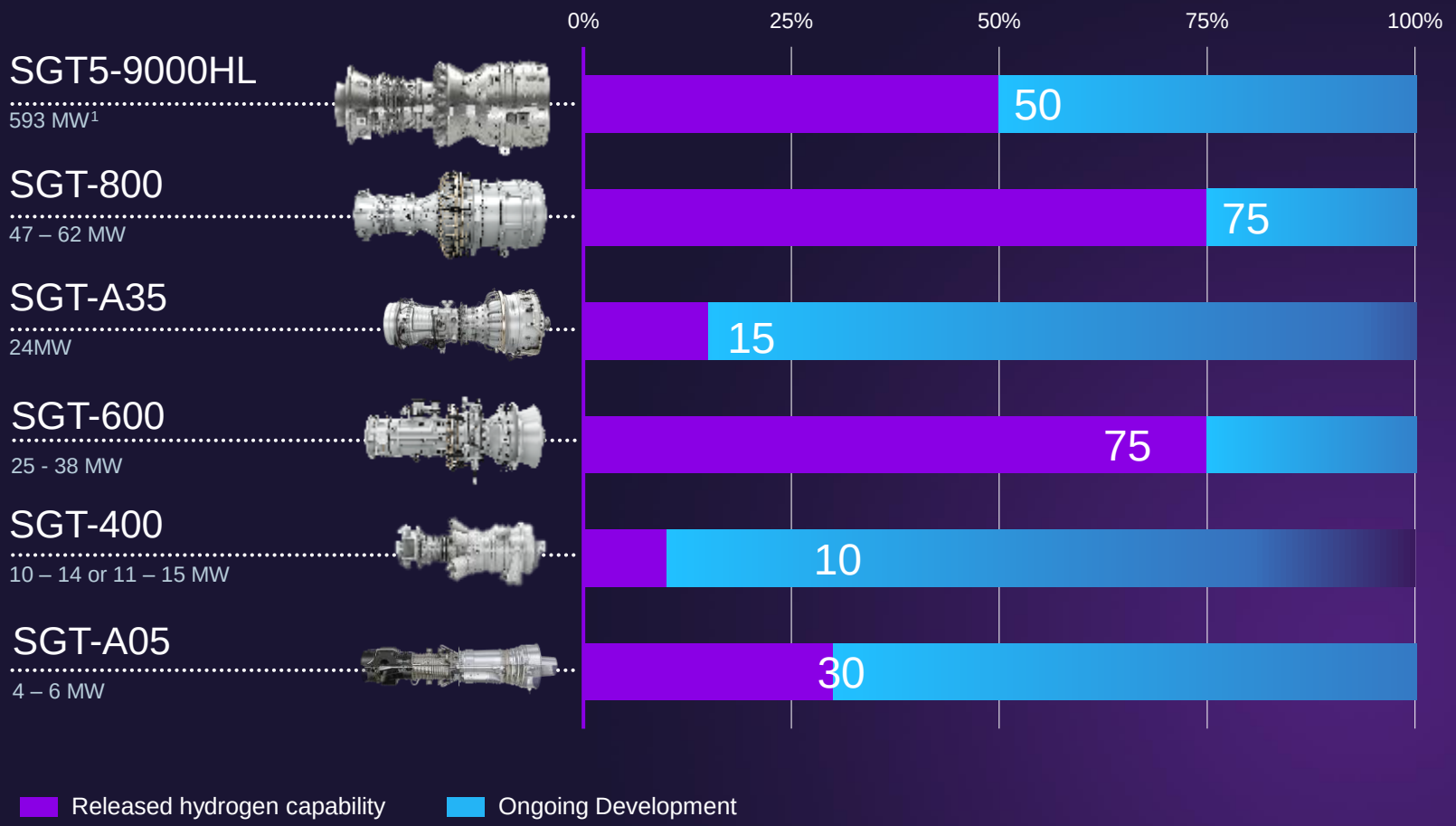
Siemens Energy occupies a leading role in the energy industry



e-Liquids | Electricity | Hydrogen | Carbon Capture | Siemens Energy Divisions

Hydrogen capabilities apply across the entire gas turbine range

Technology development pathway to burn 100% Hydrogen in DLE configuration



Investments for upgrading the global fleet of **gas turbines** by making them a **key technology for transitioning** to a decarbonized world

until **2023** – **100%** H^2 in **Small Gas turbine (SGT-400) demonstration**

until **2030** – **100%** H^2 in **Industrial and Heavy-Duty Gas turbines**

1 The performance may be reduced based on H_2 concentration, emissions requirement and power rating
All turbines equipped with DLE burner technology. Power output in MW at ISO ambient conditions and natural gas

Hydrogen Capability: Aero-derivative Gas Turbines

100% Hydrogen firing possible today in WLE configuration

Gas turbine model	Power Output[1]	H_2 capabilities in vol. %
50Hz or 60Hz		
SGT-A65	58 to 71 MW	15 – 100
SGT-A45	41 to 44 MW	100
SGT-A35	25 to 38 MW	15 – 100
SGT-A20	13 to 17 MW	100
SGT-A05	3 to 6 MW	30

Over 250,000 hours of recorded operation since 1968 on fuel blends containing up to **80 vol%H2**

Decarbonization Roadmap

Efficiency

Immediately Available Solutions:

- Optimized Efficiency With Digital & Product Solutions

Carbon Neutral Fuels

Known Solutions requiring test & demonstration:

- Proven Fuel Flexibility Experience
- Capable of co-firing with Natural Gas up to 100% H2 (DLE 15%vol H2)
- Planned Engine Test Using Methanol

Zero Carbon & Low NOx

Additional solutions requiring development

DLE burner WLE burner Diffusion burner with unabated NOx emission

Customer example: providing clean energy to Braskem, Brazil

Scope

- 2 x SGT-600
- 3 x Reciprocating Compressors
- E-houses
- Extension of HV Substation
- Advanced load-shedding System
- Software for plant control

Features

- Co-Generation plant fueled by residual process gas with **high hydrogen content**
- **6.3% CO_2** and **11.4% water consumption reduction**
- **100% plant availability** through redundant design
- 15-year contract to **Build, Own & Operate** the cogeneration plant

Key Success Factors

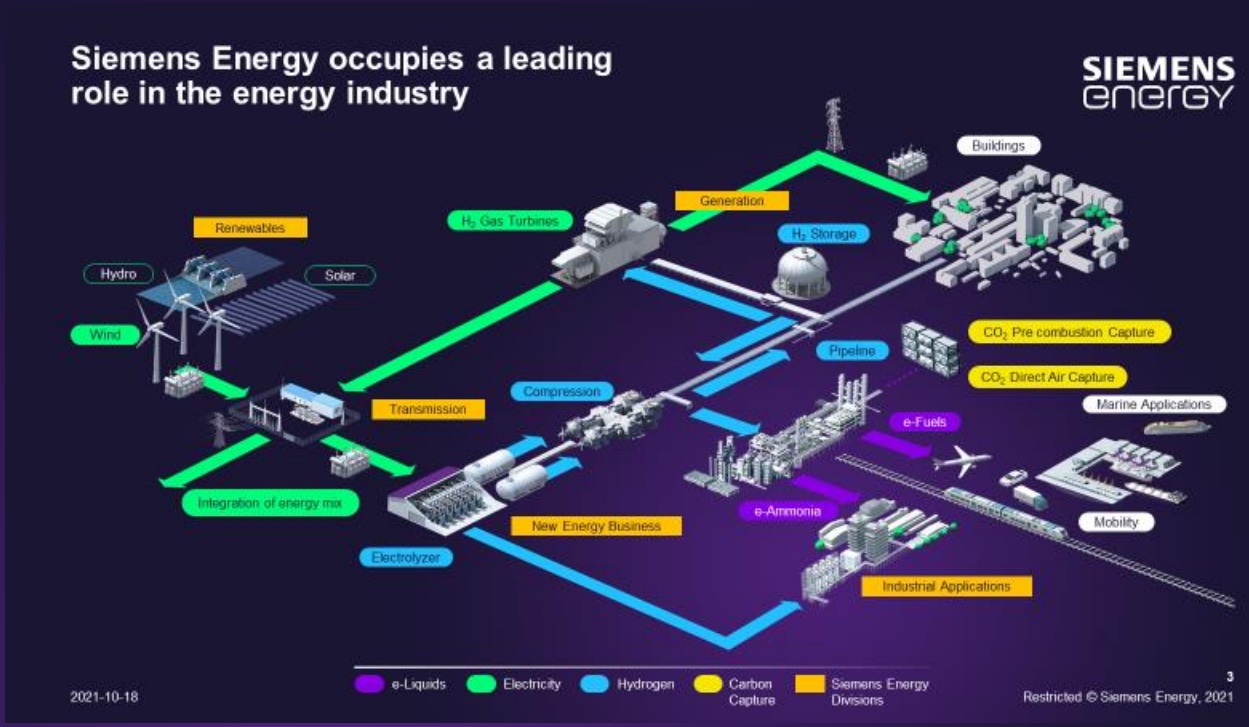
- ✓ Partnerships with leading companies
- ✓ Co-creation and deep dives to develop transition roadmaps
- ✓ End-to-End solutions and services

up to 60% H_2

Co-Firing in combined cycle solution, providing 38 MW and 160 tons of steam per hour

Final Remarks

- Siemens Energy is **supporting steps towards a carbon neutral society** with solutions across the entire decarbonization value chain
- With increased presence of renewables, **gas turbines** will have a greater role to play to support **grid stability and back-up power reliability**
- **Hydrogen**, as a substitute fuel for gas turbines, will be a key **enabler for decarbonization**
- **By 2030**, the complete portfolio of **Siemens Energy gas turbines** will be upgraded to have **Hydrogen burning capability of 100%**



Thank you

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BlueVault

Electrification of existing powerplants

- Installation Of BlueVault Energy Storage And BlueDrive Power And Drives Connected To Offshore Wind Turbines For Electrification Of Powerplants
- Driven by the need to decrease **operational costs** (fuel and maintenance) and **emissions**

Bussiness Proposal

- Entire electrical solution from Siemens Energy. Siemens Gamesa providing wind turbines
- Adding energy storage solution for electrifying existing powerplant and allowing optimization of performance of existing installed GTs.
- Existing Siemens Energy gas turbine powerplant ensuring electrical power capacity availability whenever there is a shortfall

Sustainability impact

- Increased efficiency
- Reduction of CO_2 and NOx footprint

Operational Benefits

- Significant OPEX reduction (fuel and maintenance cost savings)
- Increased revenue due to higher efficiency
- Increased powerplant reliability
- Increased safety and HSE (less noise and vibrations on the platform)
- Universal system for all possible powerplants to connect