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Prof. Tagliabue's research in nanophotonics for energy aims at uncovering and engineering emerging light energy conversion pathways enabled by non-equilibrium and interfacial effects in nanomaterials and at solid/liquid interfaces.

Nanophotonics has indeed transformed light-matter interactions at the nanoscale, with optical nanoantennas bridging the size gap between the light wavelength and charge, heat and ion transport scales. This enables unprecedented control over energy conversion processes and the harnessing of non-equilibrium phenomena, though understanding remains challenging due to complex multi-physics interactions. By developing controlled experimental platforms and bridging micro- and macro-scale characterization methods, Prof. Tagliabue's work on the optoelectronics of nanomaterials and solid/liquid interfaces has clarified the mechanisms underlying three complementary light energy conversion pathways and demonstrated associated proof-of-concept devices.

Plasmonic Catalysis. Metallic nanoantennas generate non-equilibrium charge carriers that enhance chemical reactions. Prof. Tagliabue's work revealed critical details of charge dynamics and transfer at interfaces, advancing plasmonic catalysts for solar fuels production and photochemical energy storage.

Hydrovoltaic Energy Generation. Fluid flow over charged surfaces results in electrical energy generation (hydrovoltaic effect). Prof. Tagliabue's research highlighted the critical role of chemical equilibrium at the interface. Her group demonstrated efficient evaporation-driven hydrovoltaic devices that work at high salt concentrations (seawater), opening new possibilities for renewable energy production.

Thermonanophotonics. Absorbing optical nanoantennas can act as fast nano heaters. Prof. Tagliabue's research clarified photo-thermo-optical effects in silicon nanoresonators and led to reconfigurable metalens designs, enabling adaptable devices in optics and energy.