What Tesla used in Colorado Springs at 1899 ? The mystery of magnifying transmitter.

First we must recognize simple formula of pulsed power of frequency f.
Power can be calculated as multiply of single burst of energy times the rate of repetition.
One example would be discharging capacitor many times per second.

(1) E =0.5*C*U^2 – energy stored in capacitor

Because power is always computed against 1 second we have:

(2) P = E*f where f is count of repetition of discharge of capacitor per second or frequency of pulsing

This is true when powering pure resistive loads by capacitor pulsed discharges.

However Tesla used magnifying transmitter.
If we think about his magnifying transmitter as a simple RCL system powered by energy stored in capacitor will will end up with RCL circuit with loosely coupling and that would be AC oscillations and no energy gain.
What we really need is to study disruptive discharge in Tesla Colorado Notes and the way he computed power gain.

What we are looking for is to discharge capacitor into coil system having so called Q factor as big as possible.
Q factor is dimentionless value. „Higher *Q* indicates a lower rate of energy loss relative to the stored energy of the oscillator; the oscillations die out more slowly „

Q=2*Pi*E(total)/E(dissipative) where E(total) is energy in a oscillating system, while E(dissipative) is energy lost during each cycle of oscillation

E(total)=Q*E(dissipative)/2*Pi

Here we must analyse what really Tesla did. He discharged energy of capacitor into coil system (primary and secondary) and prevented energy to slosh back to capacitor by using disruptor. He also analysed and minimized mutual inductance between primary and secondary. He also minimized resistance of primary and maybe also secondary (this has to be checked in Colorado Spring Notes). Clearly what he wanted was HIGH Q FACTOR. That's why magnifying transmitter.

What we finally got ? **A coil system with good inductance, small capacitance, low resistance, low mutual inductance and high Q. Like shorted coil or Tesla magnifying transmitter.**

We discharge capacitor at slower rate into this system and secondary oscillate longer so our capacitor energy is dissipated over time. Ideally if we assume as Tesla did - only secondary is the main factor (due to minimized resistance and mutual inductance) we have Q factor for single coil.

Q= w*L/R , where w= 2*Pi*f , here f is frequency of RCL of coil self-inductance with coil self-capacitance

E(total) = w*L/R * E(dissipative)/2*Pi=(f*L/R) * E(dissipative)

but E(dissipative) is a fraction of energy we stored in coil from capacitor discharge. Assuming that initial energy from capacitor is dissipated linearly (the same bit every cycle) which s very crude assumption we have

E(dissipative) = E cap / n = 0.5*C*U^2/n

where n = f / fin , f – frequency of self-oscillation of coil , fin – frequency of disruptive discharging capacitor into coil

E(total) = (f*L/n*R)*0.5*C*U^2

Here we assume once again that power of impulse system is defined by the same equation as in (2) but energy is stored in magnetic field of coil.

Finally power is a multiply of total energy of oscillating coil with frequency of oscillation assuming perfect „energy transfer" via magnetic induction.

P = E(total)*f = 0.5 * (L/n*R) * C*U^2*f^2

here the factor L/n*R is small however and gain is not visible at once
When we refactor to capacitor discharge frequency we got

P= 0.5*(n*L/R)*C*U^2*fin^2

here n*L/R can be easily made near one or two by choosing high n and quite high inductance L.

The end formula is less important then the assumptions we have got to obtain quantification of f^2. Colorado Spring notes prove that Tesla used such way to compute emf gain by Q factor minus mutual inductance. However this may not be only emf gain... when damping is eliminated...

In short terms and rougly :
maximum power of coil disruptively „kicked" by capacitor discharge may be defined as

P = Einput * Q * f

where Einput is energy of capacitor, f is frequency of self-oscillating coil Q = quality factor