A

Seminar report

On

(Based on EE -1190433001 and EE -1190433002)

EE —119043002

Wireless power transmission

Submitted

By

Vaibhav Dixit

(Bachelors of Technology)

6’th SEM

Under the guidance of

Mr. Padmesh Singh and Mr.Shashikant

PROFESSOR Department of Electrical Engineering

DEPARTMENT OF ELECTRICAL ENGINEERING

BABU BANARASI DAS UNIVERSITY ,lUCKNOW

May ,2022

CANDIDATE DECLARATION

I hereby declare that the seminar report work being presented in This report entitled “WIRELESS POWER TRANSMISSION “Submitted in The department of Electrical Engineering, FACULTY OF POWER SYSTEM AND POWER ELECTRONICS ,Babu Banarasi Das University, Lucknow is The authentic work carried out by me under the guidance of Mr.Padmesh Singh and Mr.Shashikant, Professor ,Department of Electrical Engineering, Babu Banarasi Das University, Lucknow.

Date —27/05/2022

VAIBHAVDIXIT
Department of Electrical Engineering
Babu Banarasi Das University
Lucknow

CERTIFICATE

This is to certify that this report represents the original work
Done by VAIBHAVDIXIT during this project submission as a partial
Fulfillment of the requirements for the Wirless transmission
Project of Electrical Engineering, fifth Semester, of the
Babu Banarasi Das University Lucknow

DATE—27/05/2022

VAIBHAVDIXIT
Department of Electrical Engineering
Babu Banarasi Das University
Lucknow

ACKNOWLEDGEMENT

I would like to express my special thanks to gratitude to my Teacher Mr.Padmesh Singh and Mr Shashikant who gave me the golden opportunity to do this wonderful project on the TOPIC WIRELESS POWER TRANSMISSION, which also helped Me in doing a lot of research and I came to know about so many New things I am really thankful to them.

Date—27/05/2022

VAIBHAVDIXIT
Bachelor of Technology 6 Sem
Department of Electrical Engineering
Babu Banarasi Das University Lucknow

Synopsis

1.TITLE OF THE PROJECT:

Wireless Power transmission

2.OBJECTIVE OF THE PROJECT:

The main objective Is to achieve wireless power transfer via resonant inductive

Coupling between the transmitting and receiving coils in the near field .

To demonstrate that power is successfully transferred wireless, an LED ,A Battery and dc fan is used.

3.PROJECT CATEGORY:

WIRELESS TRANSMISSION

4.LANGUAGE AND SOFTWARE TOOLS USED:

Front End :C

Operating system:Windows 10

5.STRUCTURE OF THE PROJECT :

The project Will use the principle of magnetic

Inductive coupling To transfer elecricity between

Two separate coils.

1.Materials

2.Building the coils.

3.Inducer coils.

4.Receiver coils.

5.Connecting the transitor.

6.Connecting the LED.

6.FUTURE SCOPE OF THE PROJECT:

Wireless Power transmission is the way of transfer of Power without wires. Wireless power transmission helps to connect thosarea where people are Unable to get a suitable Power source .In futureAll the devices will relate Power supply through wireless electricity.

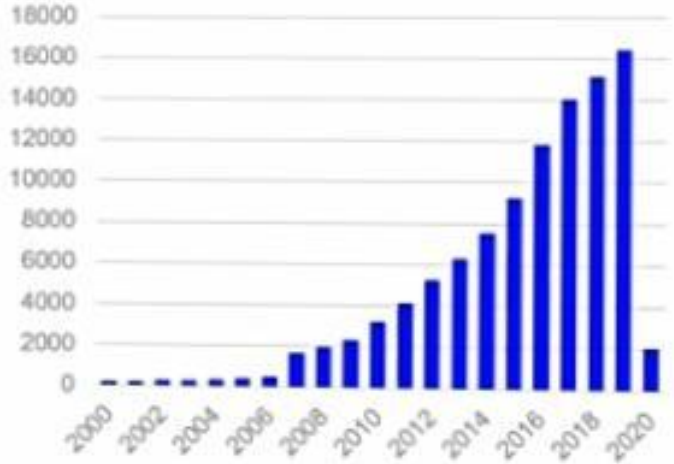
Index

History of WPT

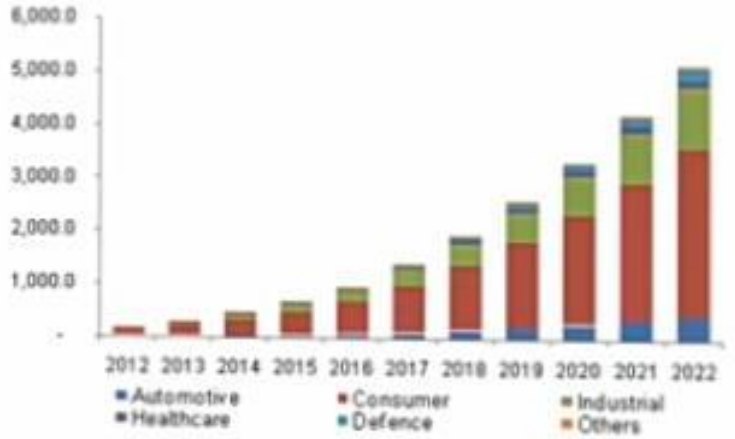
1897	Tesla files hs first in wpt	
1901	Tesla tower(demolished in 1917)	
1961	Inductive coupled coils to power across a closed chest	
1990	University of Auckland test a wpt system	
1999	University of Hong Kong	
2007	MIT wpt experiment	
2008	Intel wpt experiment	

Wireless power:a technology

Google scholar query: "wireless power" OR "inductive power

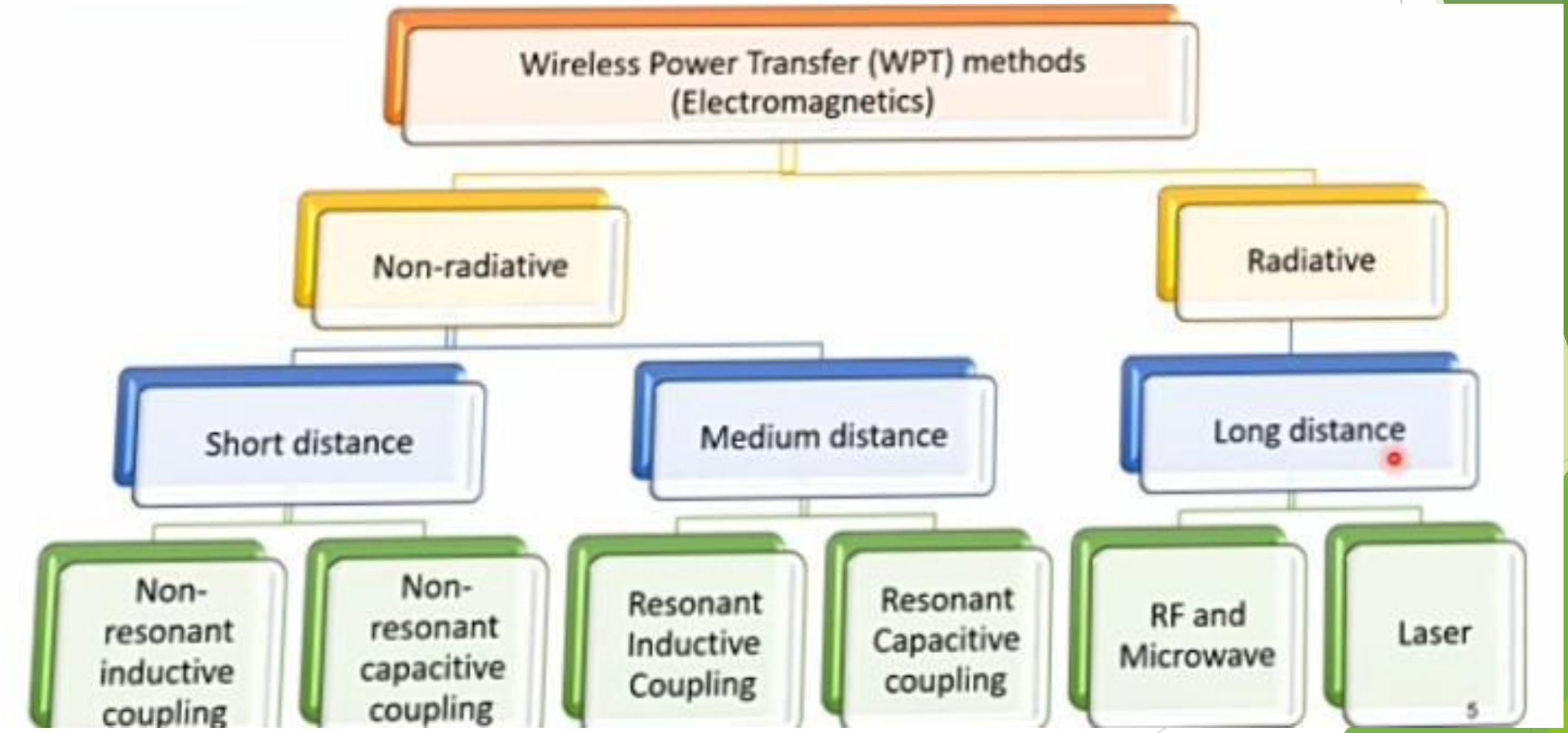


U.S. wireless charging market by application, 2012 - 2022 (USD Million)[1]

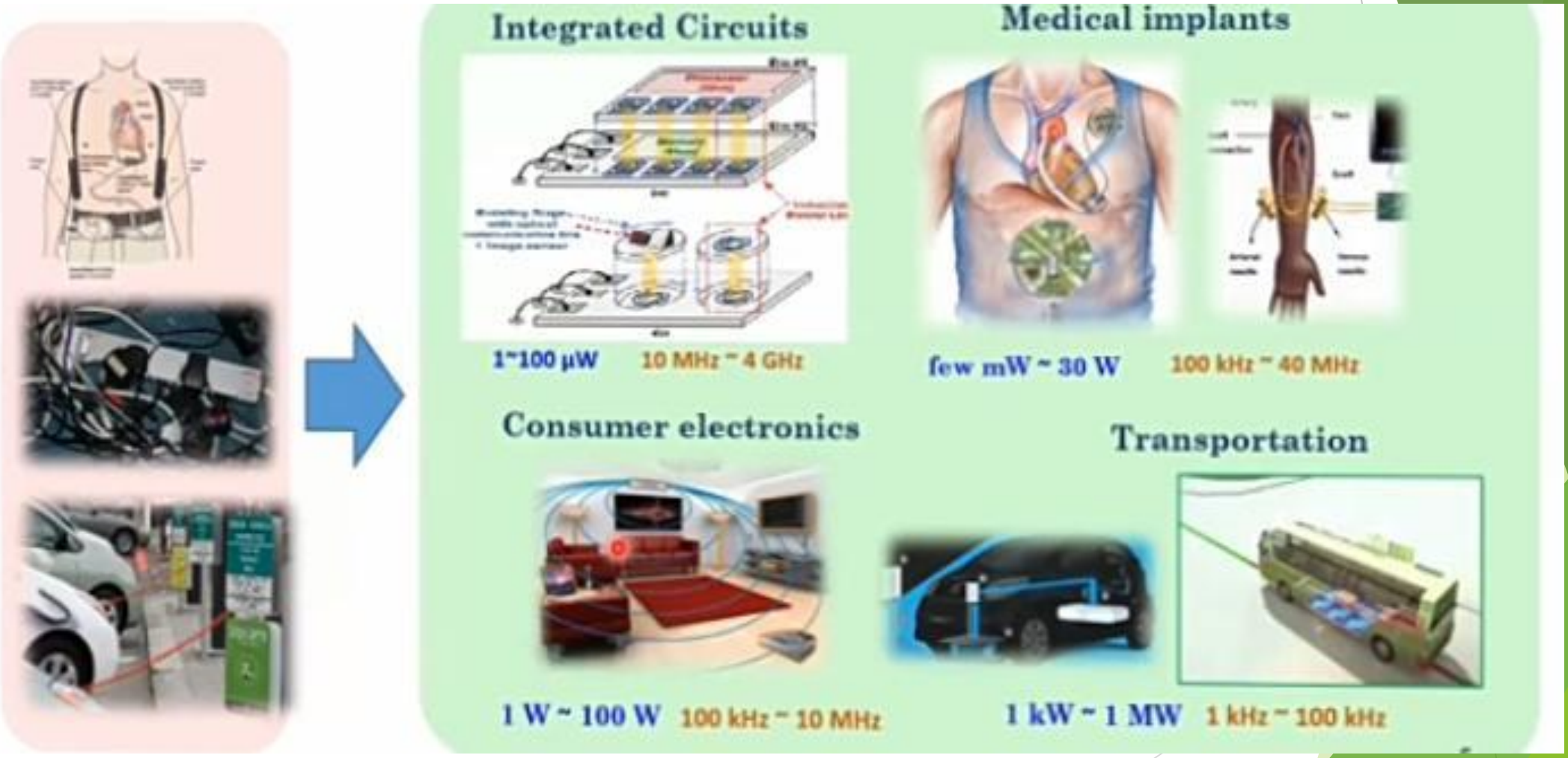


[1] Wireless Charging Market Analysis By Technology (Inductive, Resonant, RF), By Application (Automotive, Consumer Electronics, Industrial, Healthcare, Defense) And Segment Forecasts To 2022(www.grandviewresearch.com/industry-analysis/wireless-charging-market)

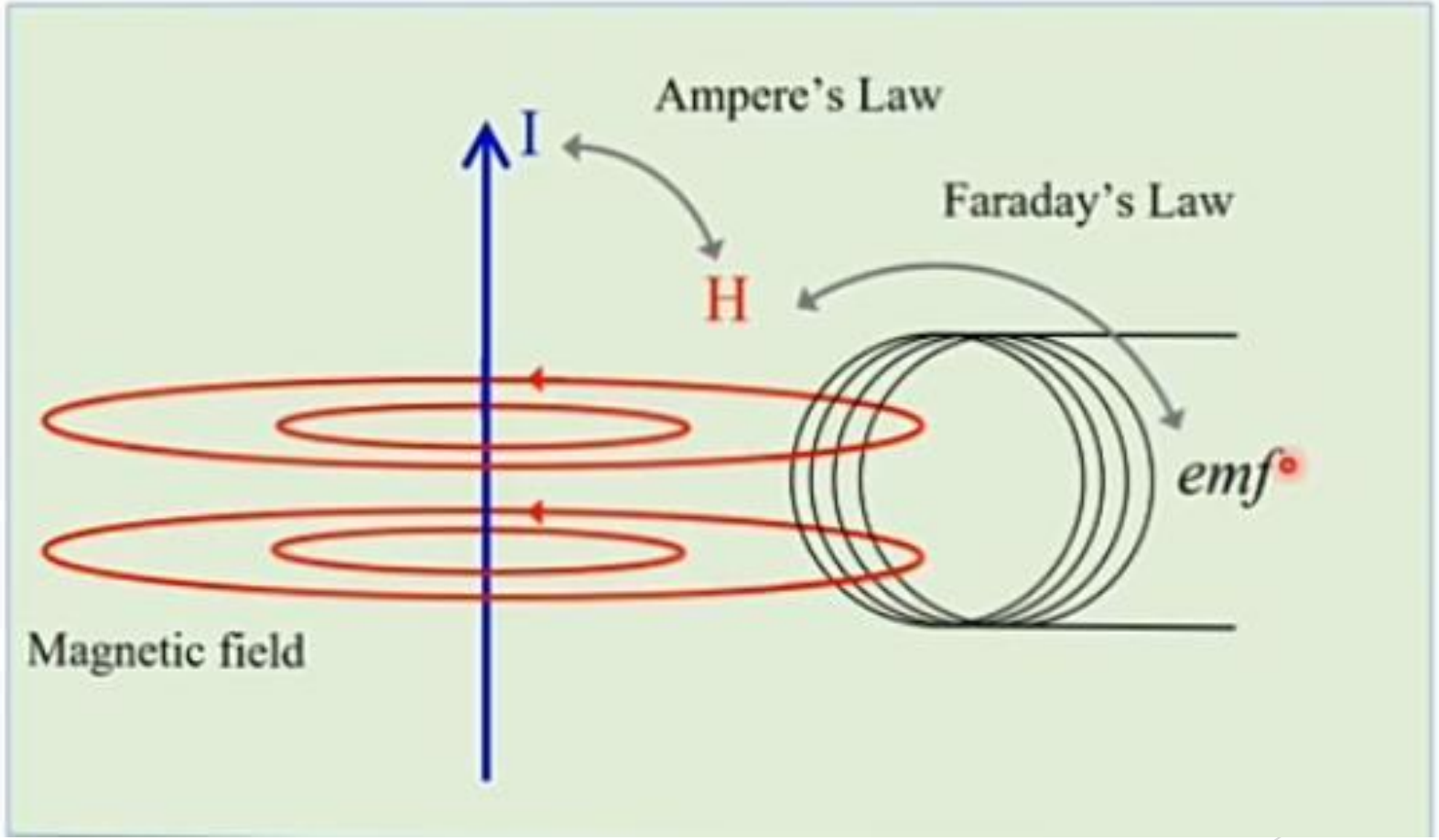
Wireless power methods



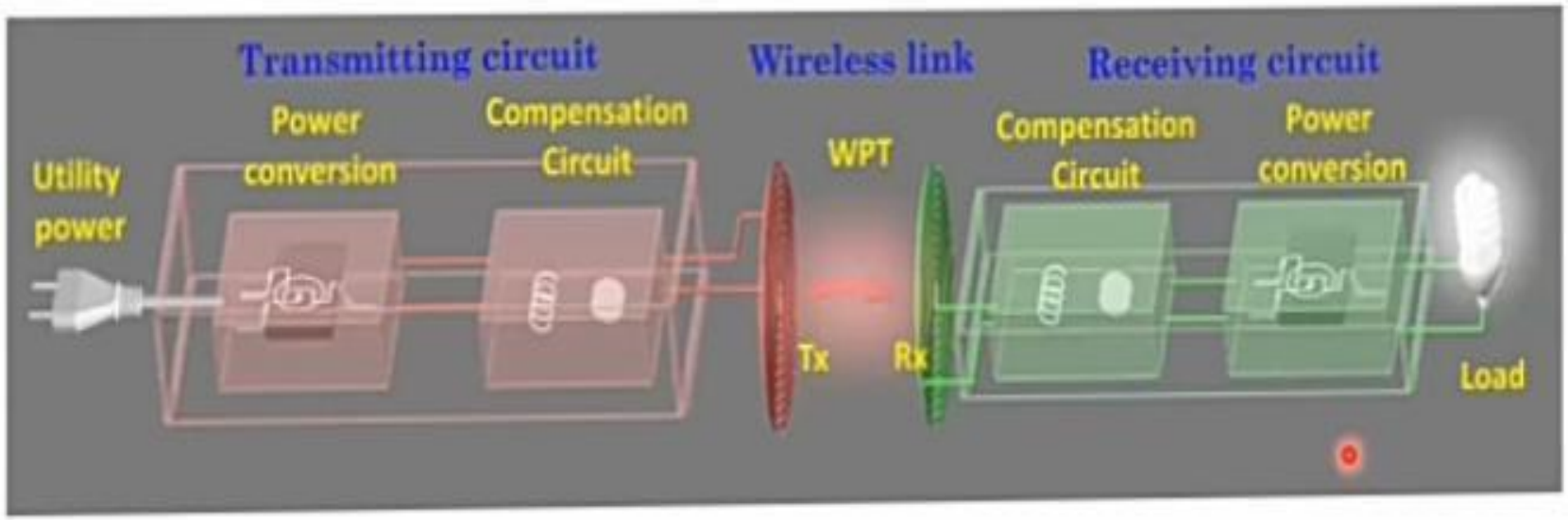
WPT Application



Bqsic of inductive Wpt



WPT System


Transmitting circuit
Wireless link
Receiving circuit
Power conversion
Compensation Circuit
WPT
Compensation Circuit
Power conversion
Utility power
Tx
Rx
Load

Basic principles of wpt coils

If length of the coil is much smaller than wavelength at working frequency

$$l_{coil} \ll \lambda$$

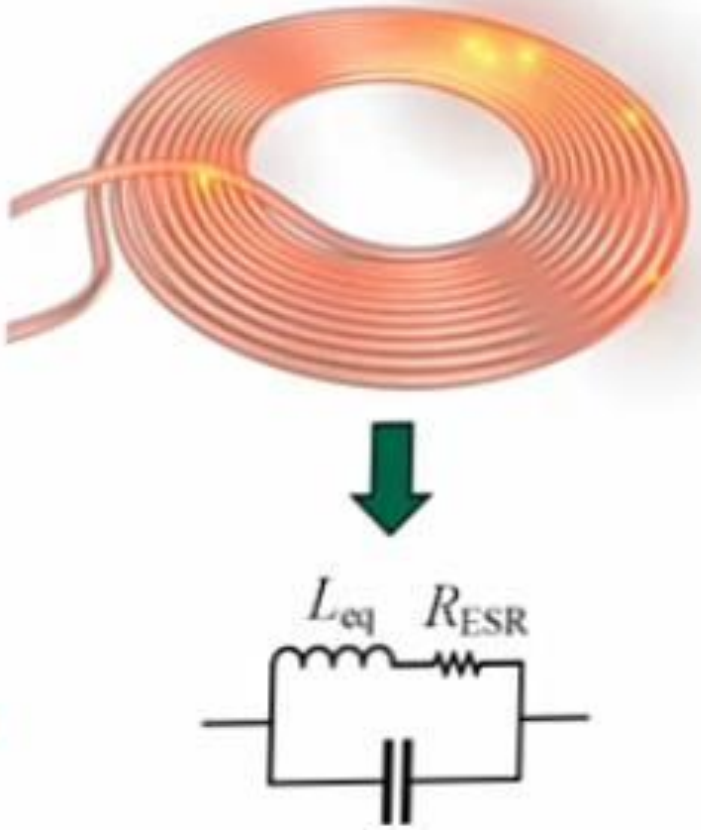
- Coil can be considered as equivalent lumped elements

Equivalent series resistance (R_{ESR})

- Ohmic resistance (Skin and proximity losses)
- Radiation Resistance

Equivalent parallel capacitance

- Typically very large reactance at frequencies less than self resonance



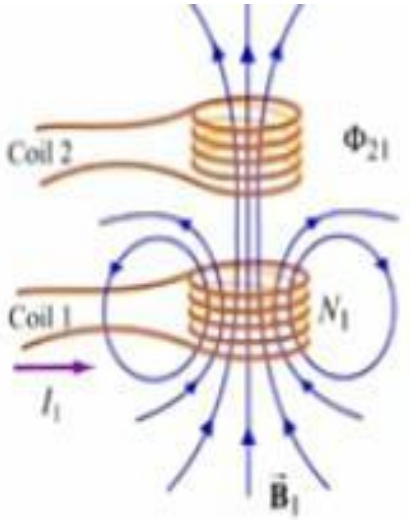
Mutual inductance

Coil 1: current $I_1 \rightarrow$ magnetic field B_1

Φ_{21} – Magnetic flux through one turn of coil 2 due to I_1

Induced *emf*

$$\varepsilon_{21} = -\frac{d\Phi_{21}}{dt} = -\frac{d}{dt}\iint_{\text{coil 2}} \overrightarrow{B_1}.d\overrightarrow{A_2}$$



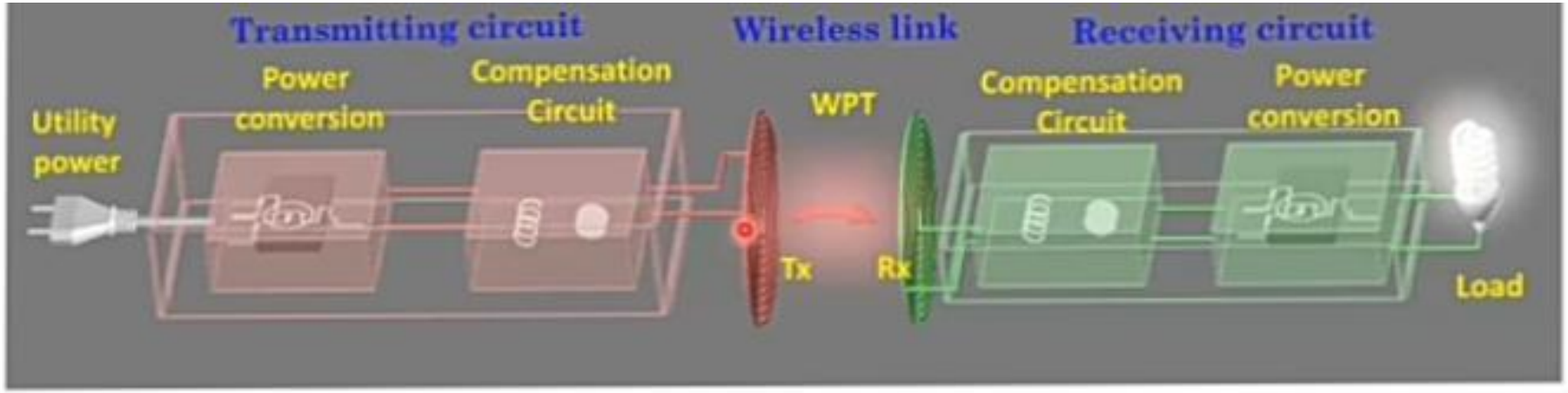
Rate of change of magnetic flux Φ_{21} in coil 2

$$\frac{d\Phi_{21}}{dt} = M\frac{dI_1}{dt}$$

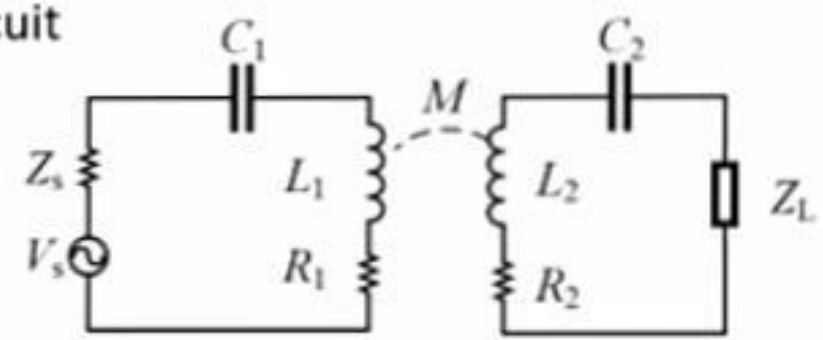
Proportionality constant M is called the mutual inductance

$$M = \frac{\Phi_{21}}{} = \frac{\iint_{\text{coil 2}} \overrightarrow{B_1}.d\overrightarrow{A_2}}{}$$

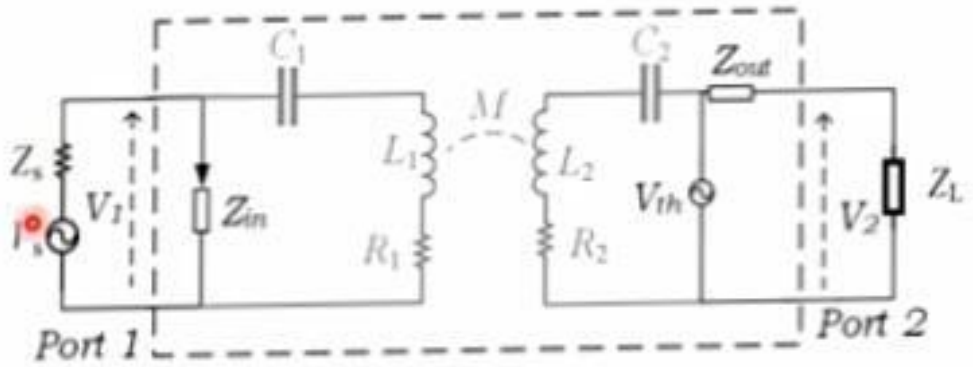
WPT SYSTEM MODELING



The equivalent circuit



WPT CIRCUIT 2 port model



In practice

$Z_s = R_s$

$Z_L = R_L$

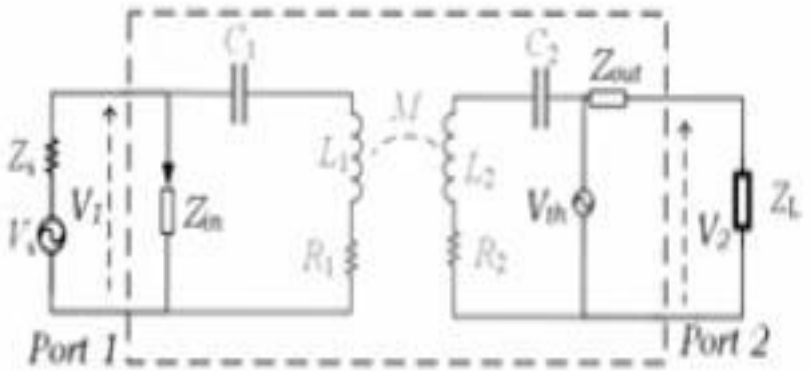
$Z_{in} = R_{in} + jX_{in}$ $Z_{out} = R_{out} + jX_{out}$

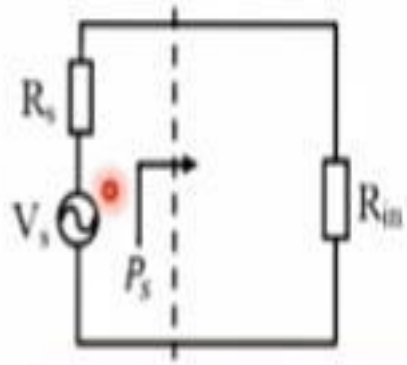
Impedance matching at Port 1

- Source matching $R_s = R_{in}$
- $X_s = X_{in} = 0 \rightarrow$ Resonance operation

Impedance matching at Port 2

Maximum power transfer





$$TP = \frac{P_{Load}}{P_{s-max}} = \frac{P_{Load}}{V_s^2/4R_s}$$

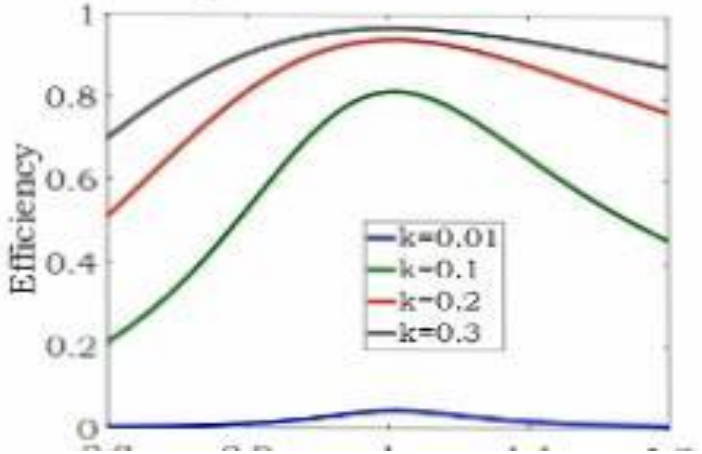
- When source port is matched i.e. $R_{in} = R_s$
- The maximum power from the source
- Losses within the source is equal to the power delivered to WPT system
  - What is about energy **efficiency**?
- Most practical sources are designed to be with very small losses

Energy efficiency

Overall efficiency depends on

- Efficiency of the wireless link – Power transfer efficiency (PTE)
- Power converter (AC source)
- Power converter (Rectifier or battery Charger)

Efficiency of the wireless link is always maximum at the resonance frequency

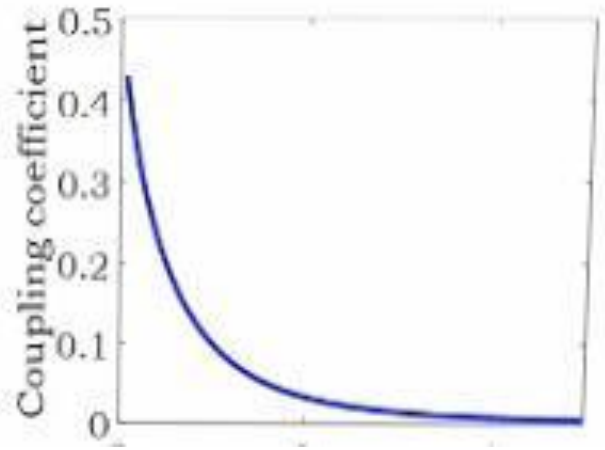


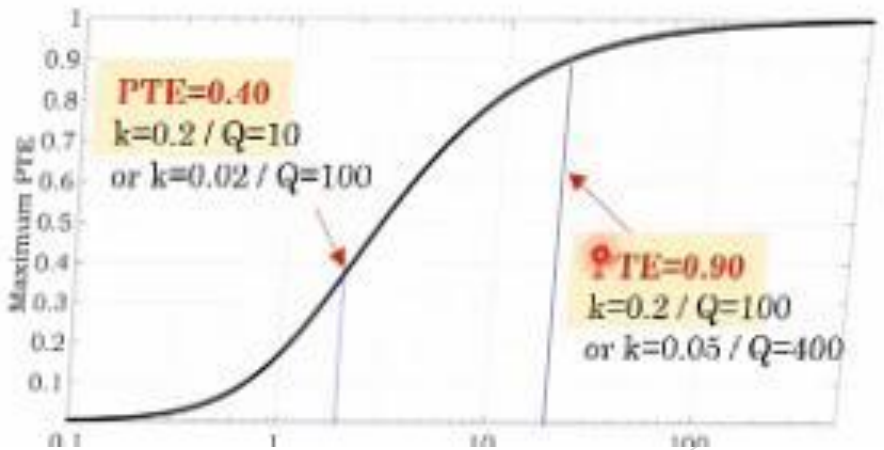
- Power transfer efficiency

Maximum PTE depends on

- Quality factor $Q = \frac{2\pi f L}{R}$
- Coupling coefficient $k = \frac{M}{\sqrt{L_{Tx} L_{Rx}}}$

$$PTE_{max} = \frac{k^2 Q_{Tx} Q_{Rx}}{\left(1 + \sqrt{1 + k^2 Q_{Tx} Q_{Rx}}\right)^2}$$





Maximizing

Coupling coefficient

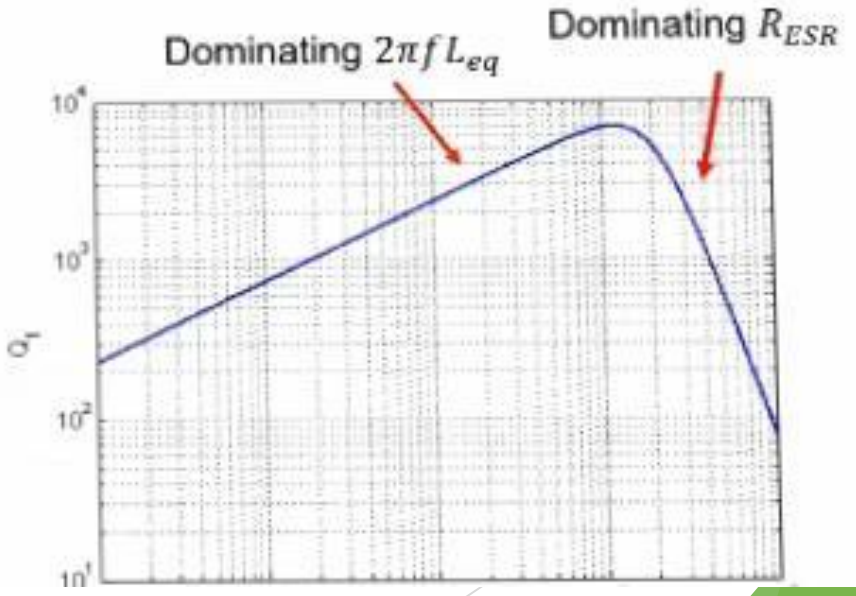
- Depends on the coil geometry and distance
- Physical size is constrained by the available space
- New coil designs to increase coupling

Maximizing Q

$$Q = \frac{2\pi f L_{eq}}{R_{ESR}}$$

Minimizing resistance

- Ohmic resistance
  → Skin losses
  → Proximity losses
- Radiation resistance
  → Small at lower frequencies



WPT COILS

Air Core coils

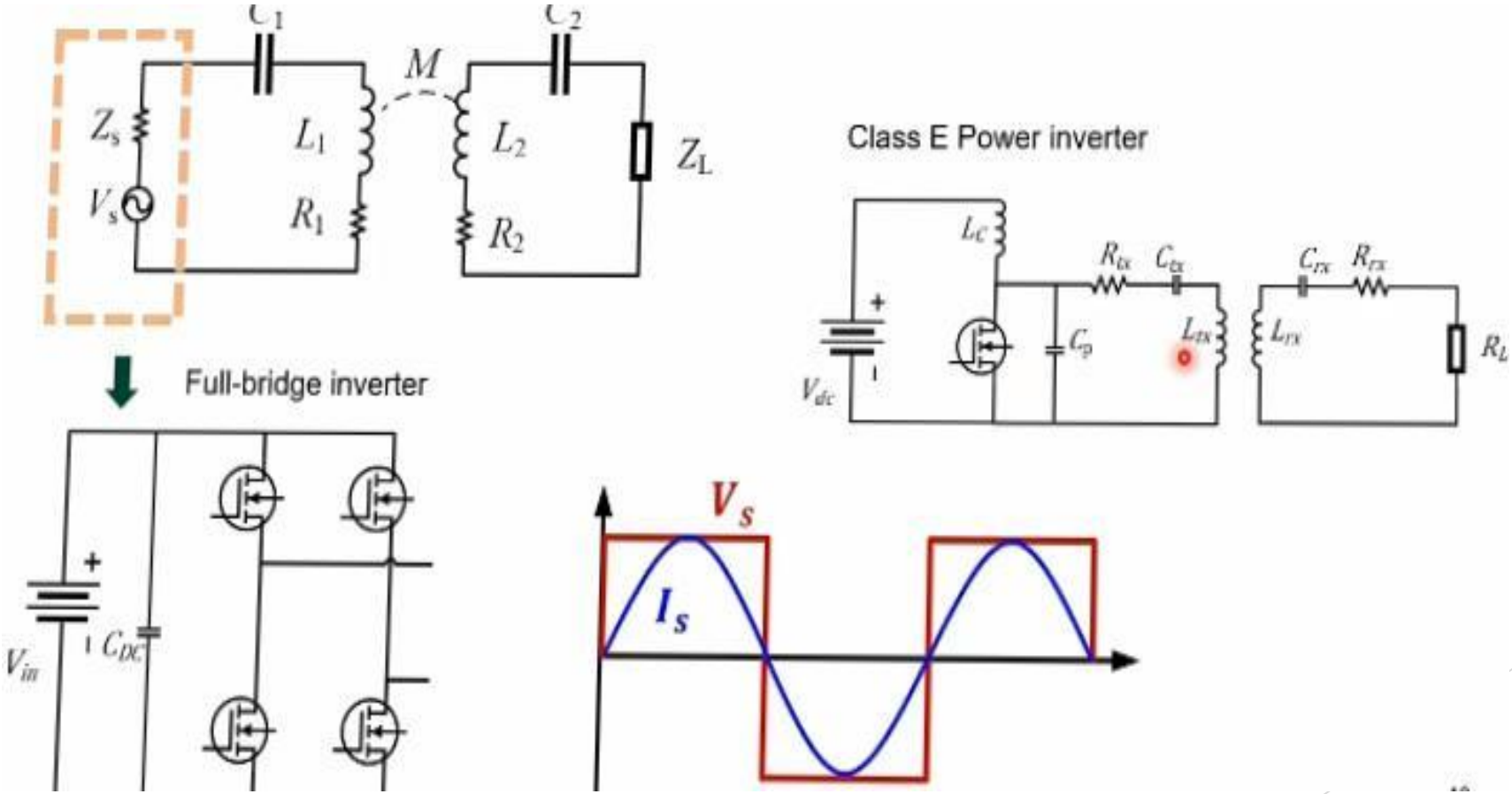
- High frequencies

Coils with Ferrite

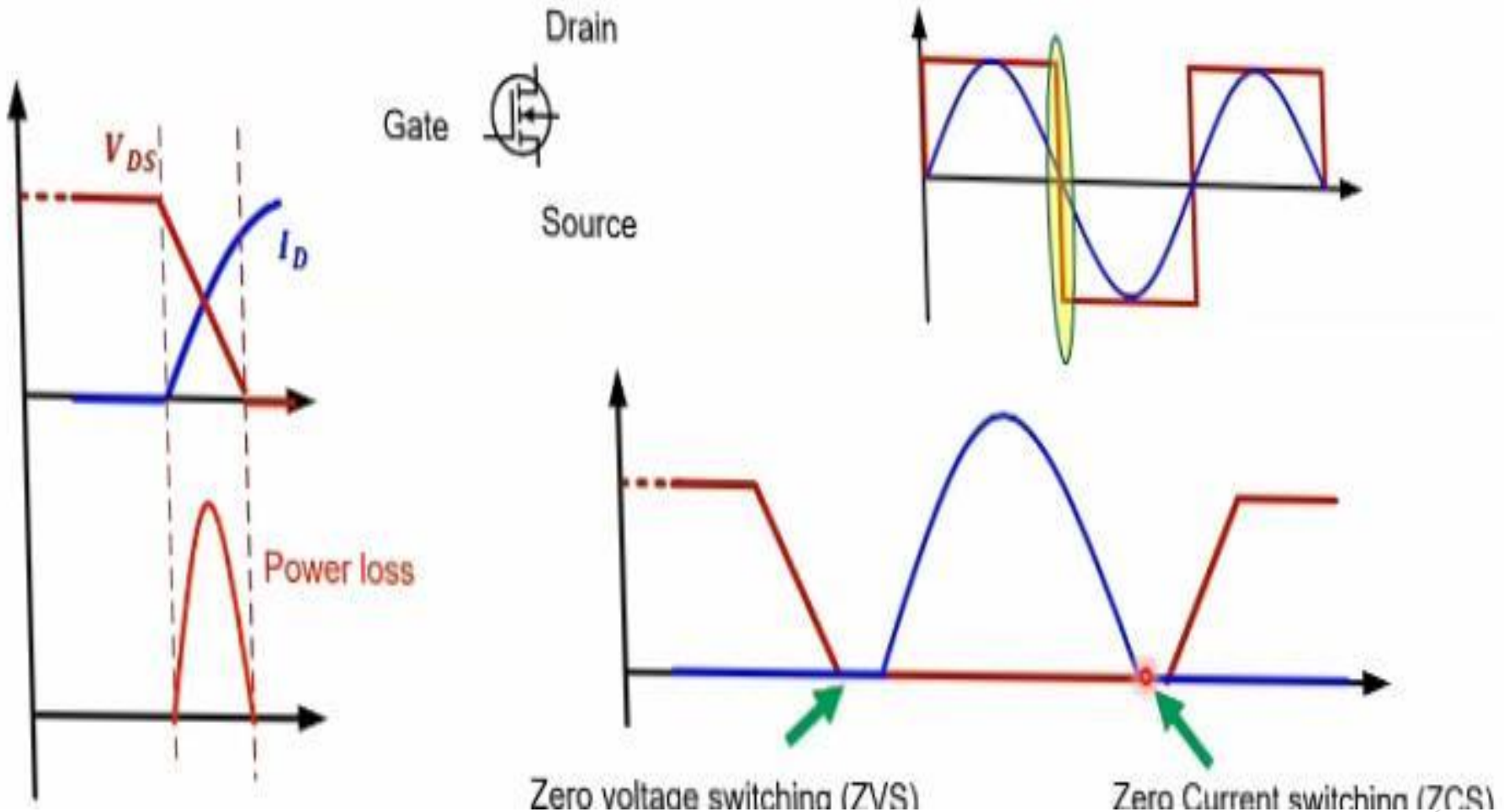
- Low frequencies

Air Core coils

High-frequency power source

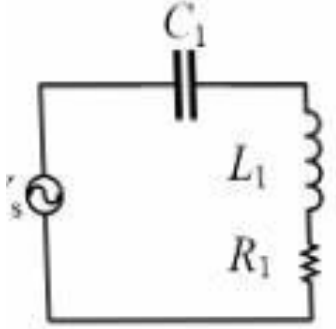


Switching lossess



Compensation circuit

- What happens when the receiver is not available?



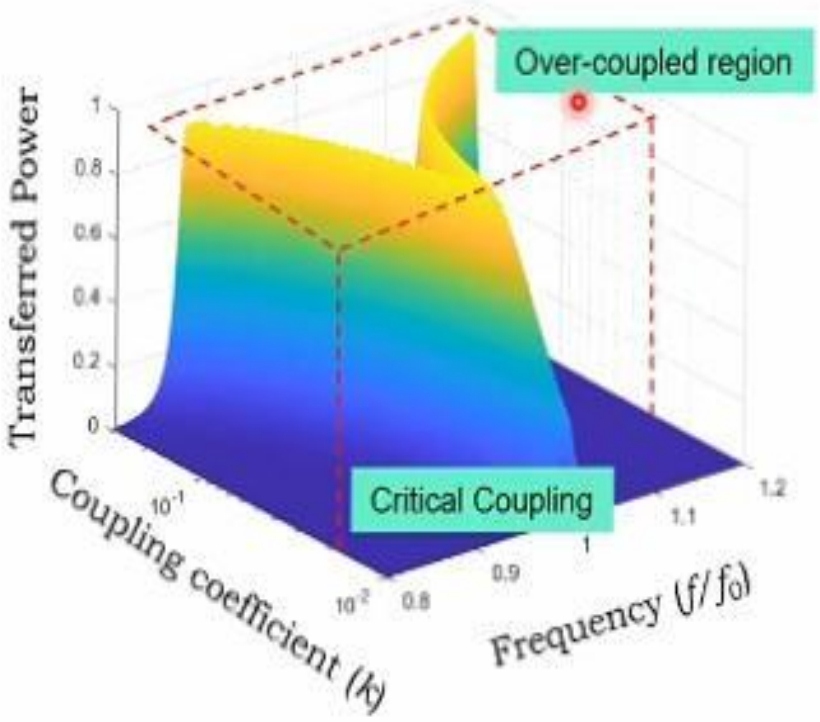
Source is almost short circuited!

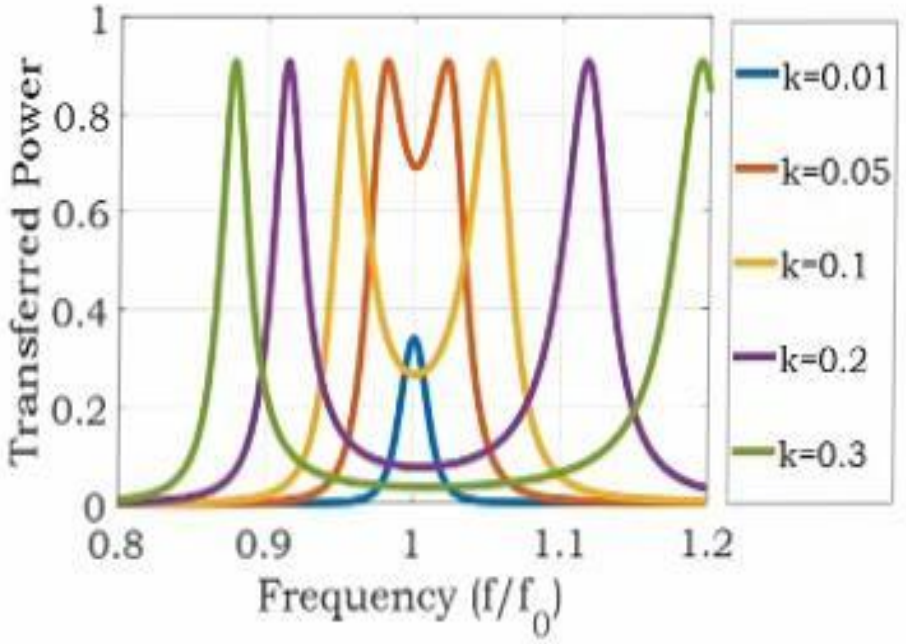
- Source should never turn on without the receiver in SS-WPT

Higher-order compensation topologies

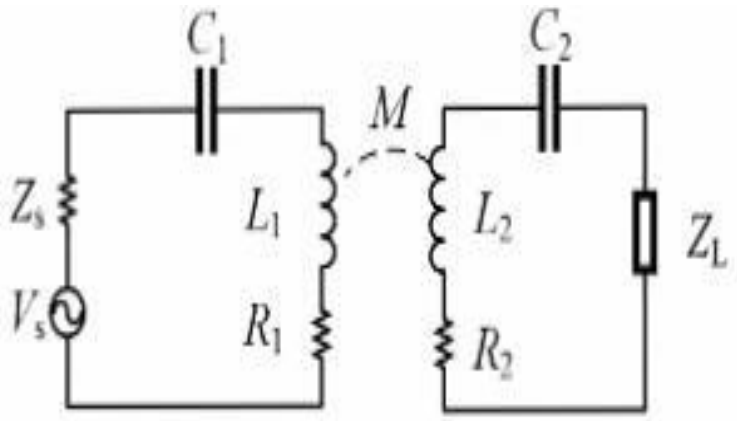
- To achieve stable transfer characteristics

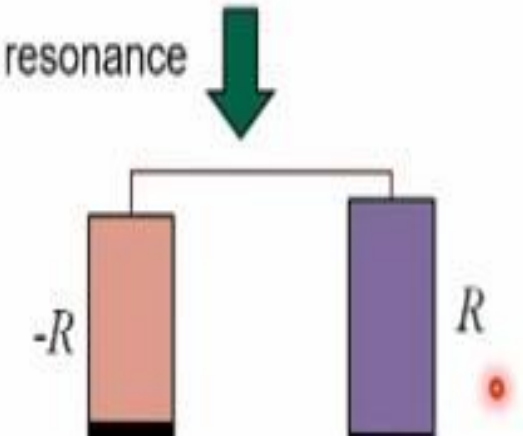
Frequency splitting

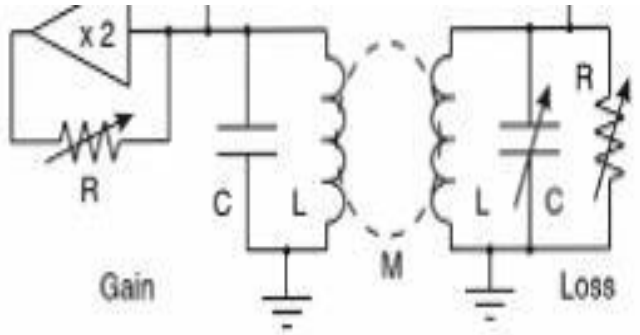




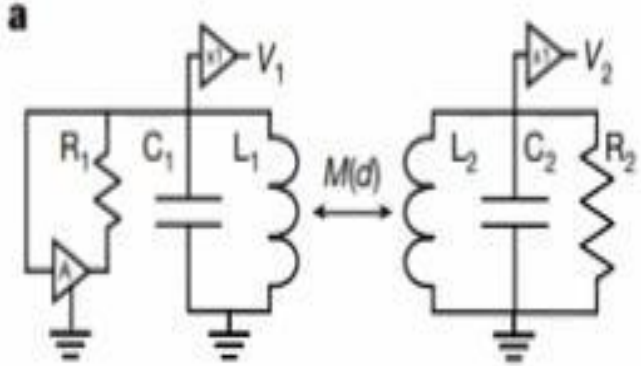
WPT as PT—SYSTEMMETRAIC SYSTEM







Schindler, Joseph, et al. *Physical Review A* 84.4 (2011): 040101.



WPT AS A PT– SYMMETRIC SYSTEM

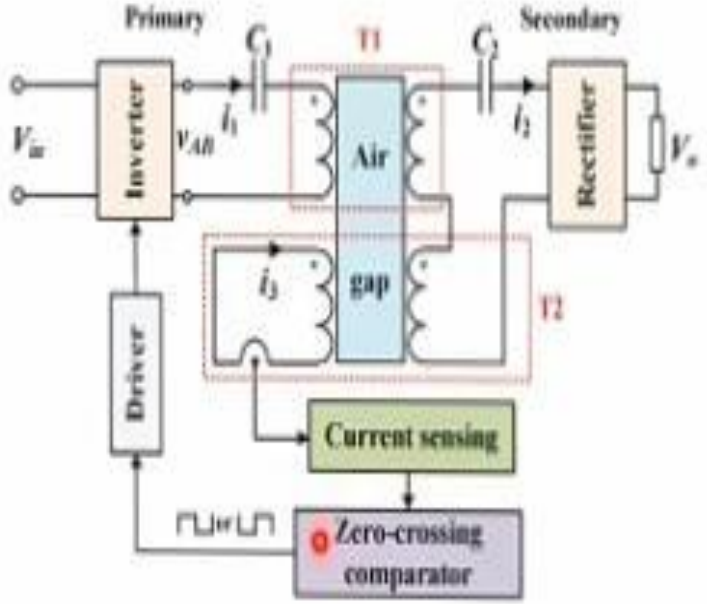
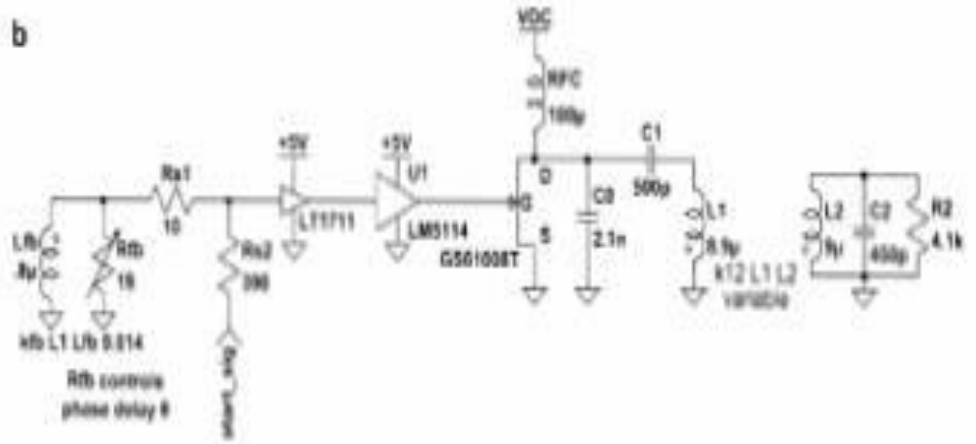


Fig. 1. Self-oscillating control diagram for SS-type CRC.



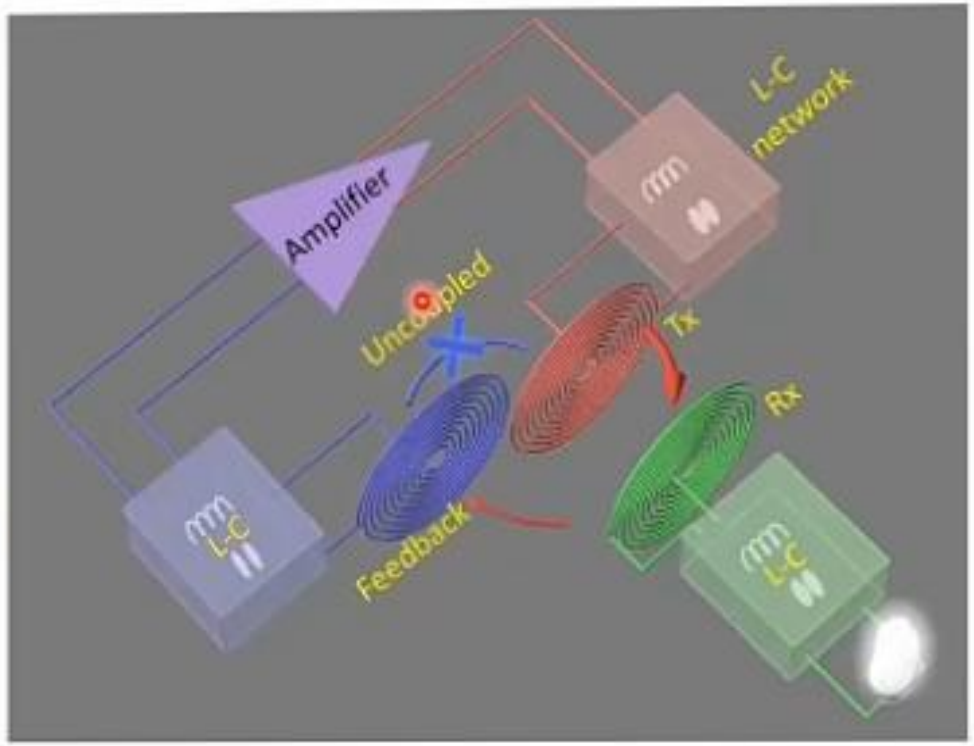
Supplementary Figure 2| Circuit diagrams used for simulations and efficiency comparisons in Fig. 1. **a**, NIC-based circuit (Fig. 1c). **b**, Switch-mode-amplifier-based circuit (Fig. 1d).

Xu, Ligang, et al. "Self-oscillating resonant converter with contactless power transfer and integrated current sensing transformer." IEEE Transactions on Power Electronics 32.6 (2016): 4839-4851.

Assawaworrarit, S., & Fan, S. (2020). Robust and efficient wireless power transfer using a switch-mode implementation of a nonlinear parity–time symmetric circuit. Nature Electronics, 3(5), 273-279.

On site wireless power generation

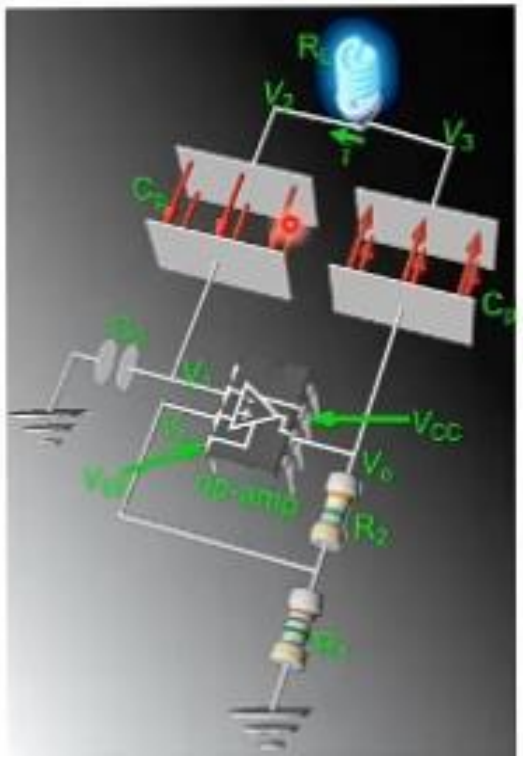
- The complete WPT system as a single unified oscillator
- WPT Link is part of the feedback
- Automatically tunes to the resonance
  - Robust against coupling variations
- No oscillation without



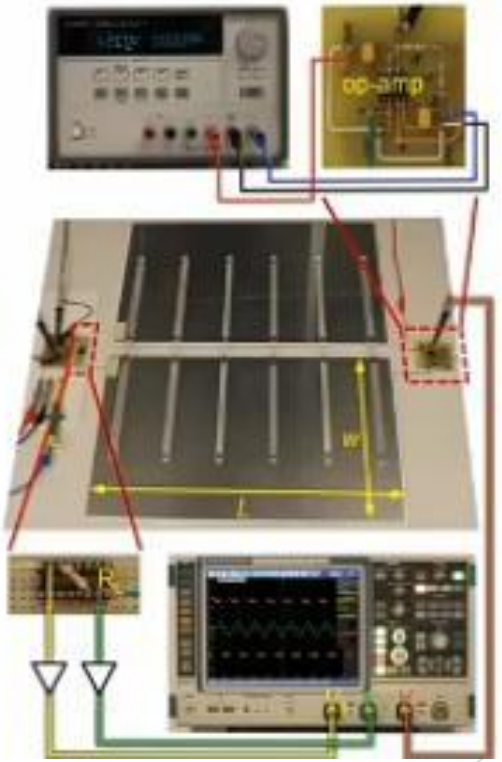
REALIZATION Capacitive coupling

- **Robust operation!**
- No load → No oscillation
- Simple topology
- Less components

Schematic



Experimental implementation

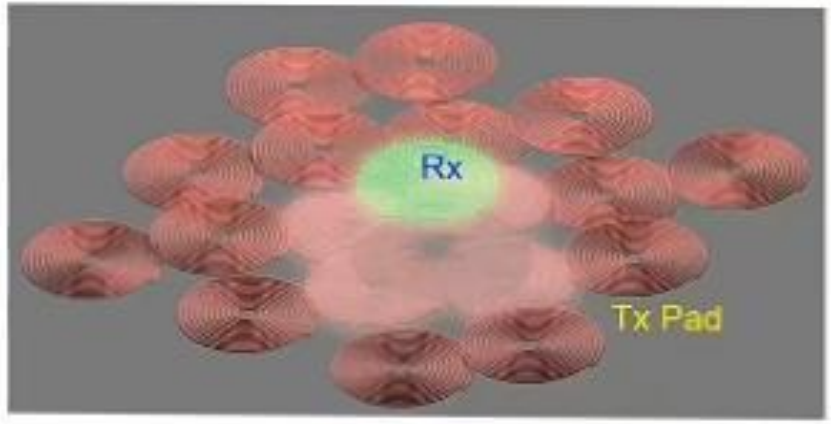


SLEF TUNING MULTI WPT SYSTEM

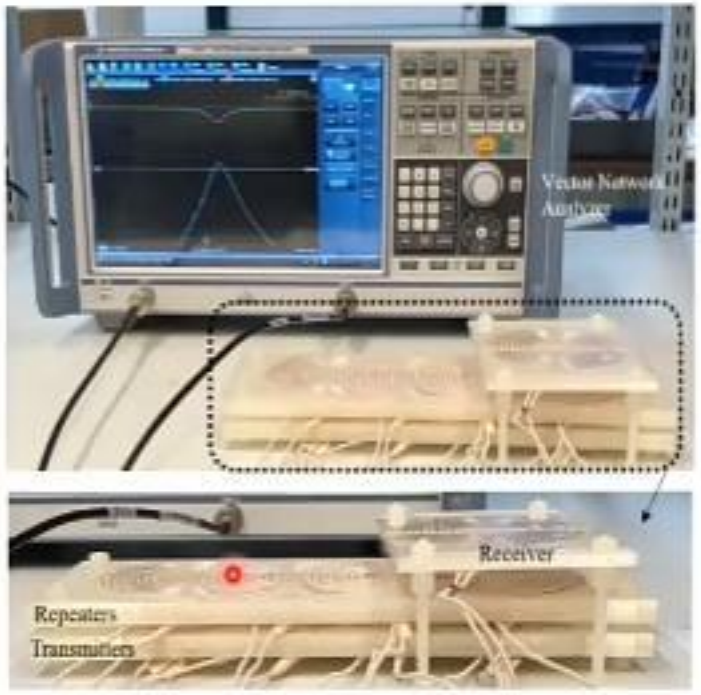
Transmitting coils near to the receiver should be activated

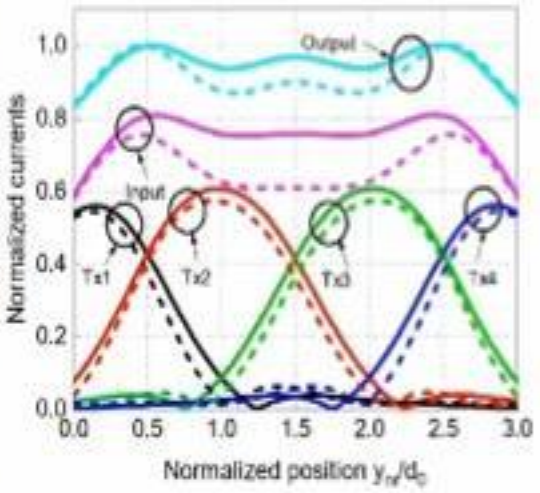
Multiple transmitters are automatically activated when a receiver is in the close proximity

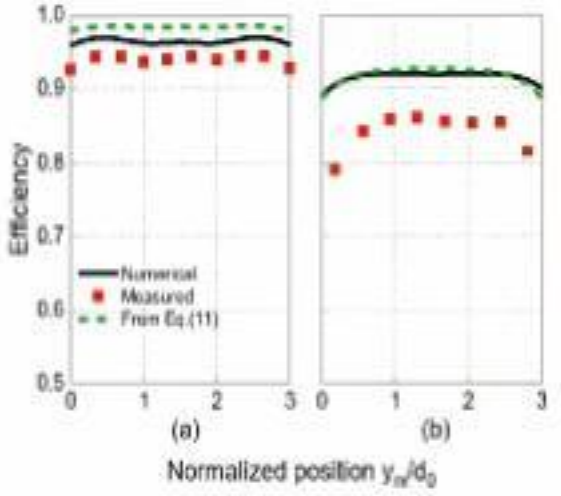
Multiple receivers can be simultaneously powered



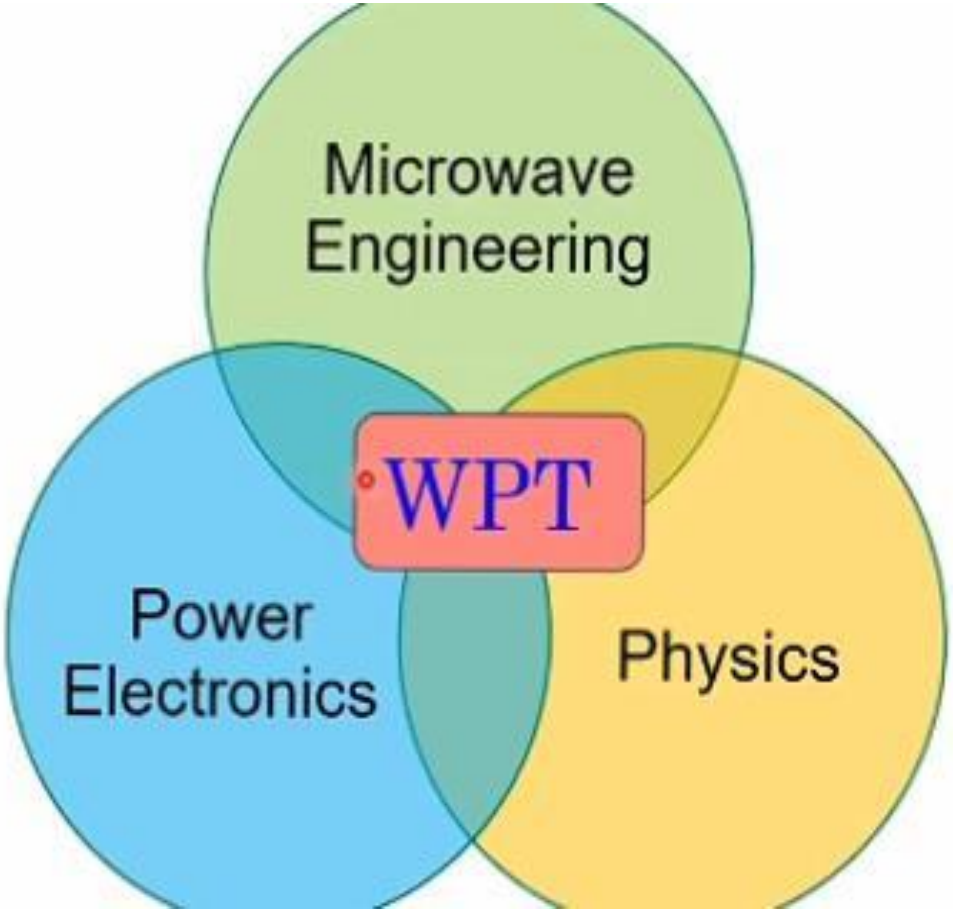
Self tuning wpt system







WPT RESEARCH



Future directions

- Applications
  - Consumer electronics market will be dominated
  - Medical implant applications
  - Electric Vehicle charging
  - Many more to discover!
- Technology directions
  - Electromagnetic field focusing
  - New magnetic materials, Metamaterials, Superconducting WPT
  - Power electronics and control
- Bio-effects due to long-term electromagnetic exposure

Thanking You