ECONOMICS OF ENERGY
INNOVATION AND
SYSTEM TRANSITION

Systems mapping of power sector reform:
Approach and emerging findings

电力体制改革系统图：
方法学与初步成果

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UCL
THE BARTLETT
INSTITUTE FOR
SUSTAINABLE RESOURCES

UNIVERSITY OF OXFORD

INSTITUTE FOR
NEW ECONOMIC
THINKING
AT THE OXFORD MARTIN SCHOOL

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Overview 议程

1. Introduction to systems mapping approach
   1. In general
   2. Use in the UK
   3. In Chinese context
2. Emerging findings
   1. New-type storage mandate
   2. ETS
   3. Coal capacity payments
3. What next?
4. Discussion / Q&A

1. 系统图方法学介绍
   1. 基本情况
   2. 在英国
   3. 在中国
2. 初步成果
   1. 配储政策
   2. 碳市场
   3. 煤电容量补偿
3. 下一步
4. 讨论与问答

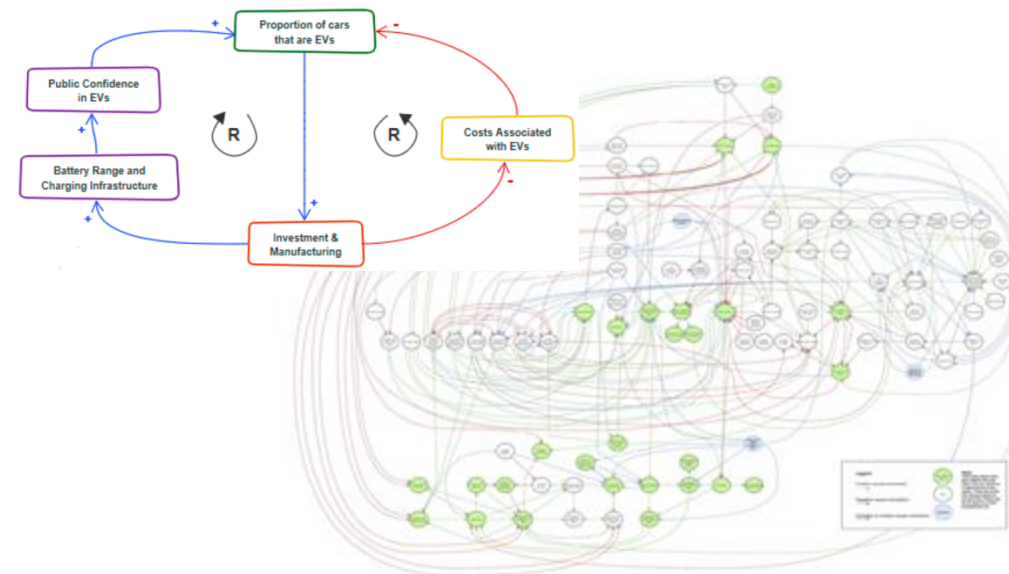ECONOMICS OF ENERGY INNOVATION AND SYSTEM TRANSITION
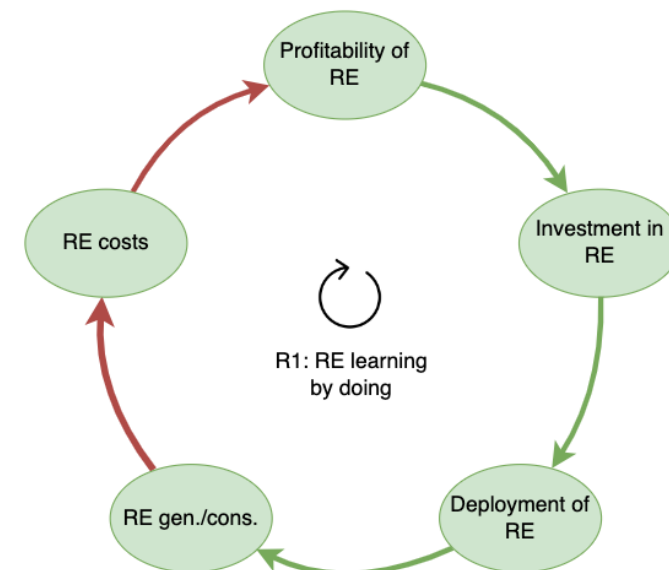
What is systems mapping? 系统图是什么？

- Lots of different types
- All use diagrams to describe a system
- Some focus on social networks, some on material and financial flows, some on causal relations

- 有很多方法学
- 每个方法都用图表来描绘一个系统
- 可以重点社交网、金融流通、物质流通、因果关系等
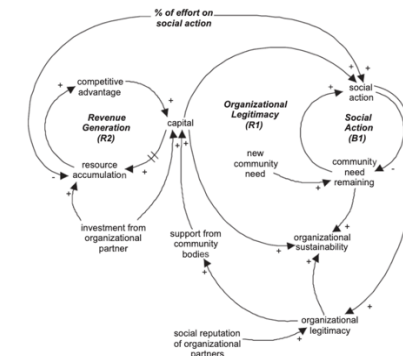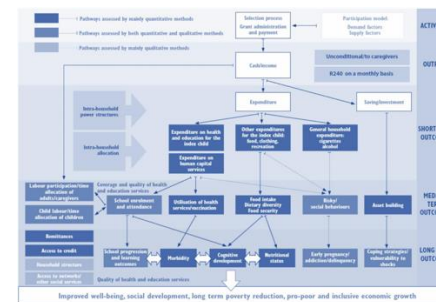
Summary of Feedback Loops

What is systems mapping? 系统路是什么？

- We focus on causal diagrams
  - Causal loop diagrams
  - Participatory system maps
- Value in
  - Process of building and thinking
  - Communicate ideas
  - Analyse qualitatively - submaps
  - Analyse quantitatively - simulation

- 我们重点因果关系图
  - 因果回路图
  - 参与性系统图
- 价值在：
  - 考虑与制定的过程
 - 表达主意
  - 定性分析
  - 定量分析（仿真）

VIRPI/BUSINESSILLUSTRATOR.COM
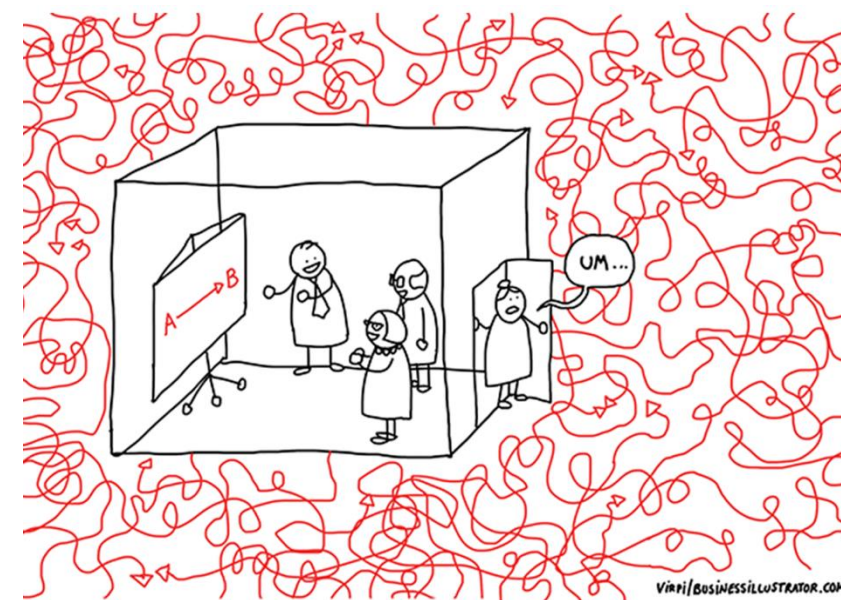
How has it been used in UK policy? 系统图在英国决策中发挥什么样的作用？

- **Well-used across UK government**
  - Stakeholder engagement
  - Policy design
  - Ex post policy evaluation
- **Regularly see system maps in policy documents, e.g.**
  - Net zero strategy
  - REMA options assessment
- **UK government building capacity to do this work 'in-house'**

- **英国政府经常会用**
  - 利益相关方参与
  - 政策设计
  - 后续政策评估
- **经常会出现在政策文件中，例如**
  - 碳中和战略
  - 电力市场安排审查选择评价
- **英国政府在加强内部能力**
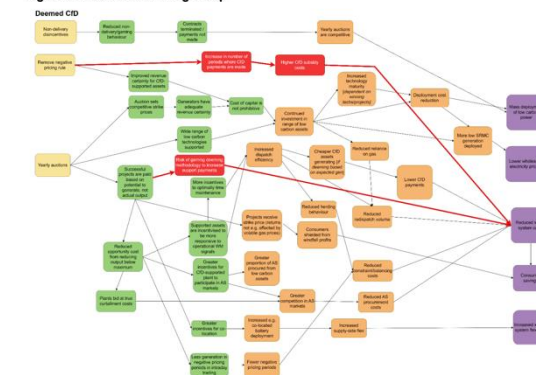
How might it be useful in China? 系统图在中国有何用？

A policy perspective

1. China's policy process is more a top-down approach than bottom-up one, less stakeholder/public engagement. Participatory process supported by systems mapping could be helpful

2. Pre-assessment of policies are dominated by quantitative modelling, if there are any, or by simple qualitative analysis. Systems mapping, in between, could provide more insights for proposed policies.

3. The complicated relationship between policy factors could be sorted/identified/captured by systems mapping, otherwise tend to be neglected and have bad impact on policy's effectiveness.

从政策角度来看：

1. 中国的决策过程倾向"自上而下"方式，公共参与和利益相关方参与比较少。系统图和参与性的手段可以补充。

2. 政策的先期评估主要靠定量模型（如果有的话），或者简单的定性分析。系统图在定量与定性的中间，可以提供更多见解。

3. 系统图可以识别和整理政策因素之间的复杂关系。否则，这些关系可能会被忽视，而给政策实施导致不良的影响。

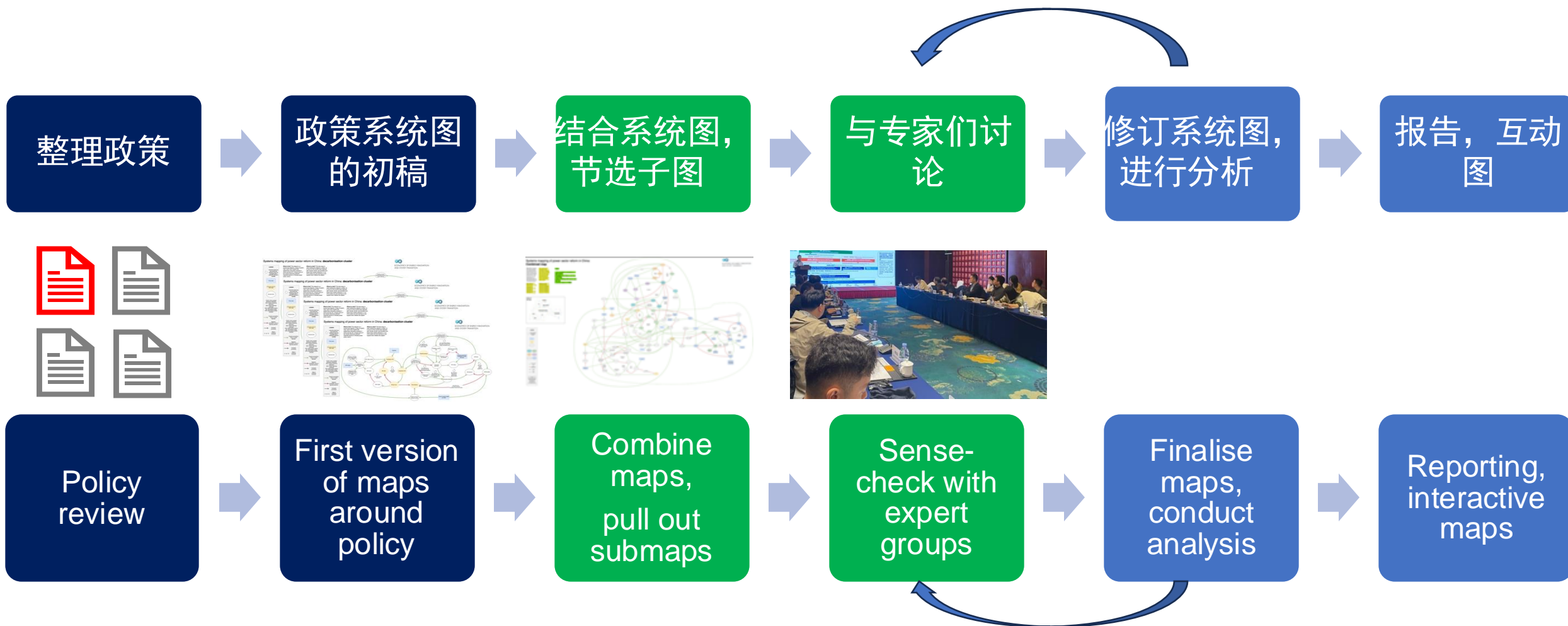# How might it be useful in China?系统图在中国有何用？

An academic perspective

1. System maps are well used across China academic researches, but rarely by government

2. Academic findings have great difficulties to impress policy makers, System mapping could be a great tool to bridge academic findings and policy decision-making.

3. BNU are now devoted to publicize it in training of teachers in primary and secondary schools. It's warmly welcomed.

从学术角度来看：

1. 学术研究者经常使用系统图，而政府很少用

2. 研究成果很难向决策者沟通。系统图可以发挥弥合作用

3. 北师大已开始以培训小中学老师普及系统图方法学，他们都很喜欢

The systems mapping process in this project
此项目中的系统图方法学

整理政策 → 政策系统图的初稿 → 结合系统图，节选子图 → 与专家们讨论 → 修订系统图，进行分析 → 报告，互动图

Policy review → First version of maps around policy → Combine maps, pull out submaps → Sense-check with expert groups → Finalise maps, conduct analysis → Reporting, interactive maps

Emerging findings 初步成果

- Many potential ways to explore and use maps
  - Explore narratives with smaller maps
  - Analyse large maps
  - Synergies and trade-offs between policies and outcomes
  - Policy complement and clash
  - Policy 'theory of change'
  - Dynamic stories
    - Policies self-amplifying or limiting

- 使用系统图有很多方式
  - 用子图探索现象
  - 分析总体的系统图
  - 政策之间与结果之间的协同作用与冲突
  - 政策之间的互补与冲突
  - 政策的变革理论
  - 动态故事
    - 自我加固与自我限制的政策

ECONOMICS OF ENERGY INNOVATION AND SYSTEM TRANSITION
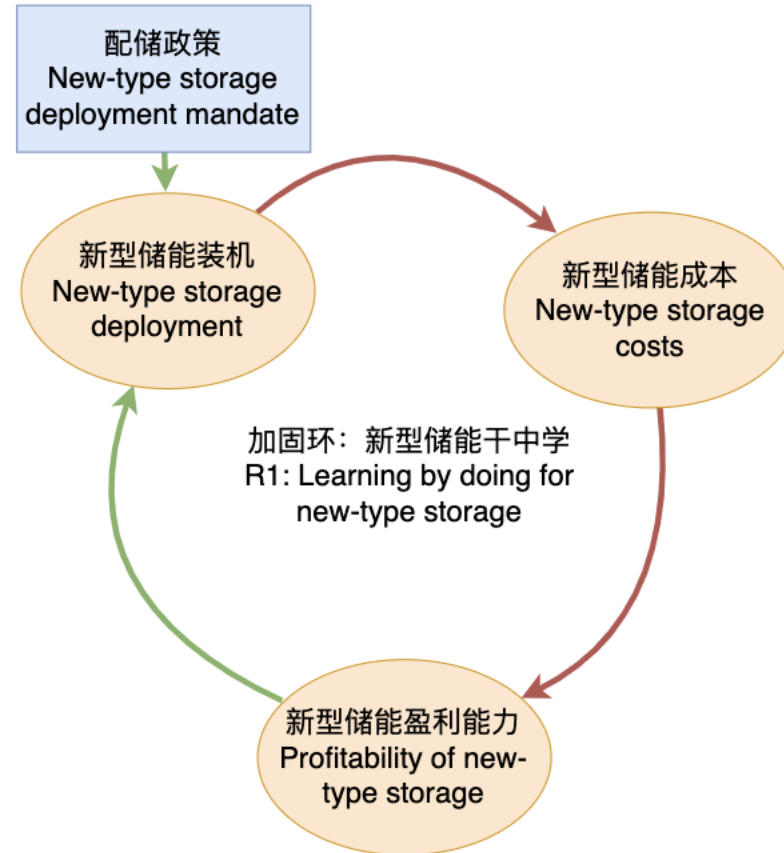
Emerging findings 初步成果

- Today I will focus on three emerging findings:
  1. **Self-amplifying policy**: the dynamic story of the new-type storage mandate
  2. **Self-amplifying and limiting policy:** in the ETS
  3. **Policy complement and clash**: the various impacts of coal capacity payments

- 今天我要讲三个初步成果：
  1. **自我加固政策：**配储政策的故事
  2. **碳市场中的自我加固政策与自我限制的政策**
  3. **政策互补与冲突：**煤电容量补偿的多种影响

A legend 图例

图例 LEGEND

平衡环和加固环： 指定重要的加固或者平衡的反馈循环
B1 or R1: Important balancing and reinforcing feedback loops are annotated with a capital **R** or **B** and a **number**

政策节点
Policy factor

结果变量
Outcomes

一般节点
Standard factor

电力现货市场节点
Spot market factors

储能节点
Storage factors

煤电节点
Coal factors

可再生能源节点
Renewable energy factors

碳市场节点
Carbon market factors

布局节点
Geography factors

正因果关系：两个节点在相同的方向上变化
Positive connection: move in same direction

负因果关系：两个节点在相反的方向上变化
Negative connection: move in opposite direction

有条件的因果关系
Weak or conditional connection

CCER: China certified emissions reductions
CEA: Carbon emissions allowance
DSR: Demand-side response
GEC: Green electricity certificate
GPT: Green power trading
LBD: Learning by doing
MLT: Mid-long term
PHS: Pumped hydro storage
RE: Renewable energy
RPS: Renewable portfolio standard

Dynamic story around new-type storage mandate
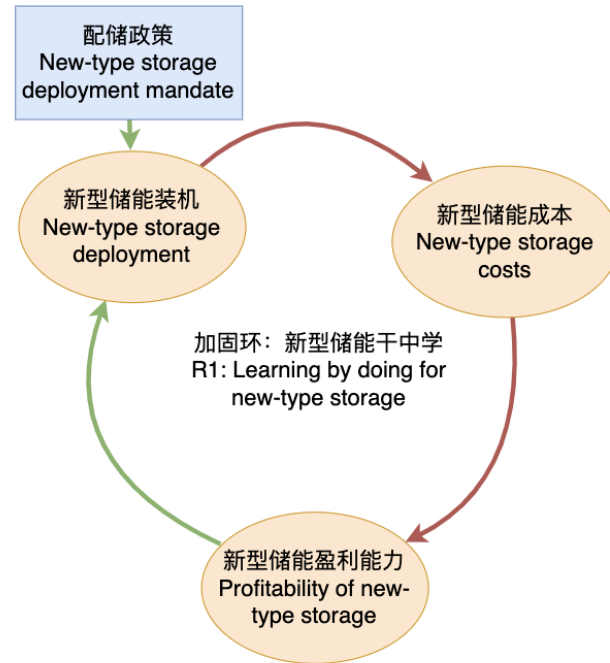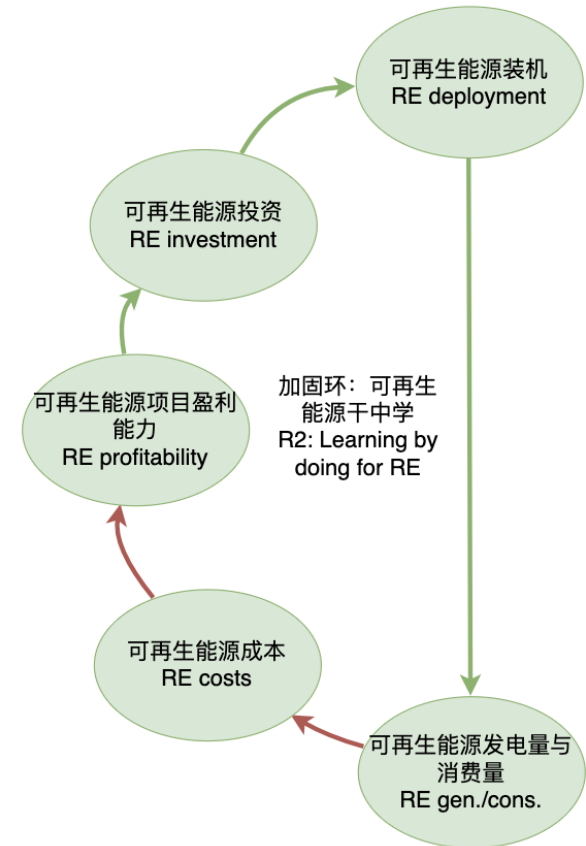# 配储政策的故事

- Mandate drives storage learning-by-doing

- 配储要求引起 "干中学"

Dynamic story around new-type storage mandate
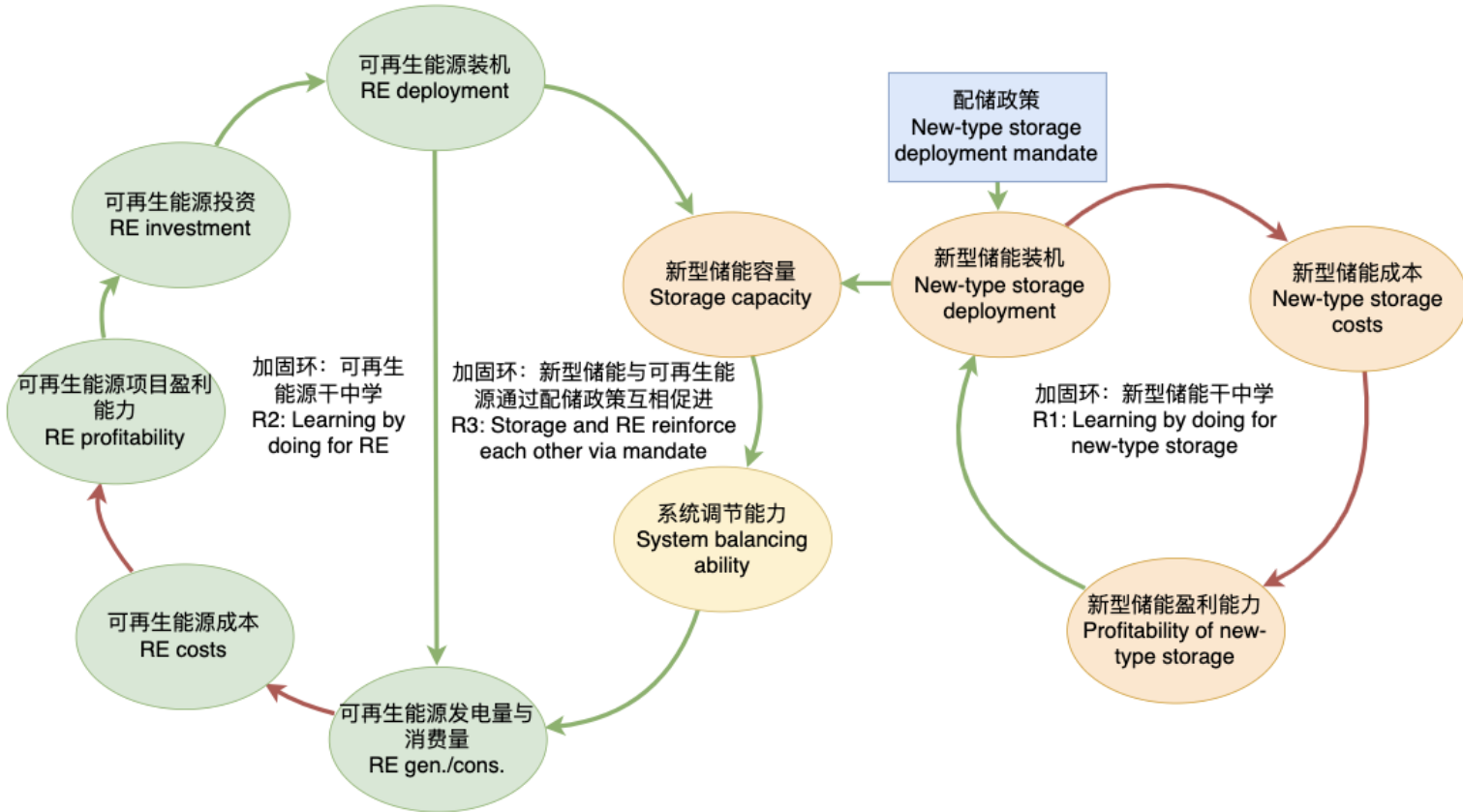## 配储政策的故事

- Mandate drives storage learning-by-doing

- RE learning-by-doing

- 配储要求引起干中学

- 可再生能源干中学
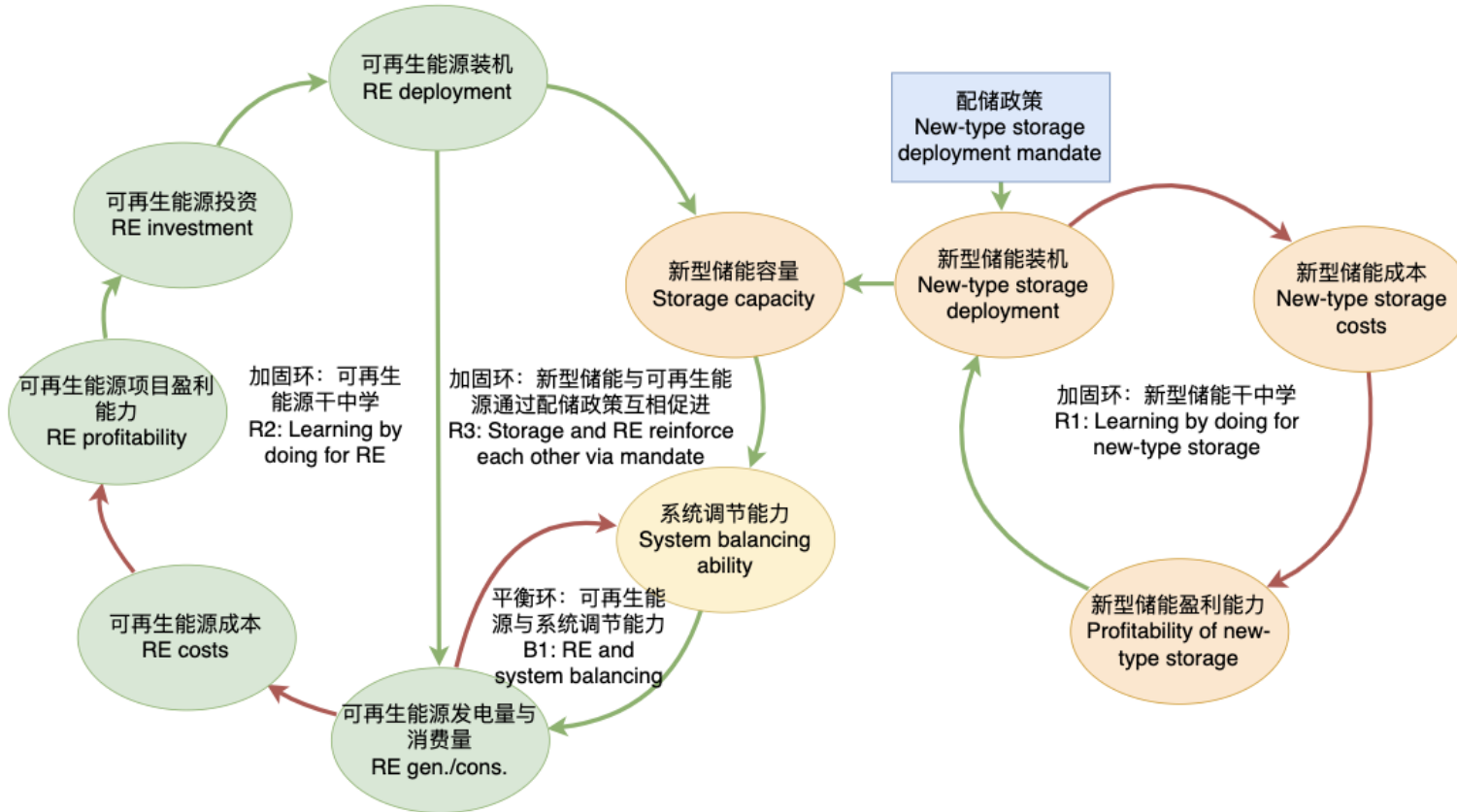
Dynamic story around new-type storage mandate
配储政策的故事

- Mandate drives storage learning-by-doing
- RE learning-by-doing

- Mandate connects the two learning-by doing loops

- 配储要求引起干中学
- 可再生能源干中学

- 两个干中学回路图被配储政策连接

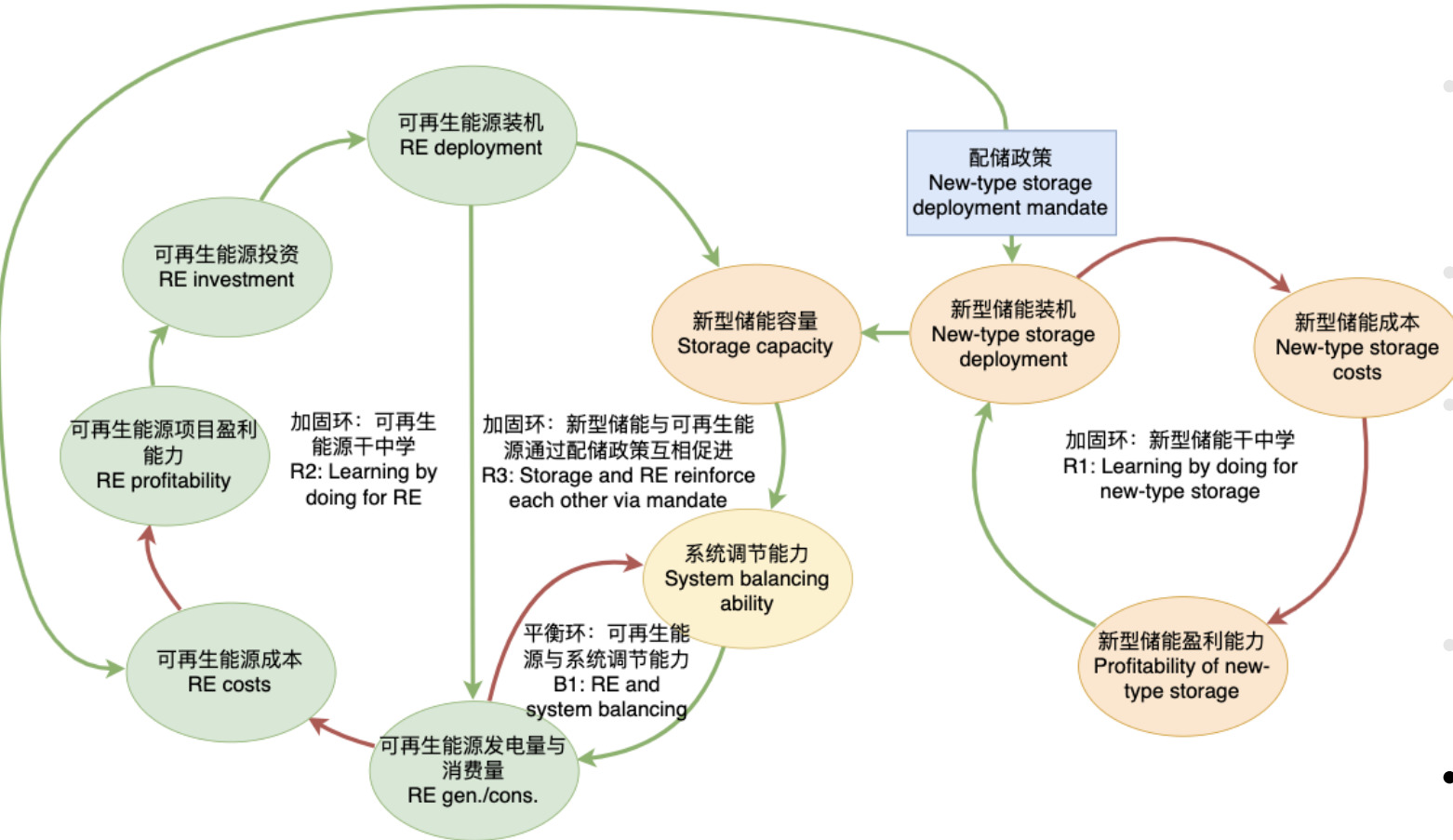# Dynamic story around new-type storage mandate
配储政策的故事

- Mandate drives storage learning-by-doing
- RE learning-by-doing
- Mandate connects the two learning-by doing loops
- **RE and system balancing**

- 配储要求引起干中学
- 可再生能源干中学
- 两个干中学回路图被配储政策连接

- **可再生能源与系统平衡**

Dynamic story around new-type storage mandate
配储政策的故事

- Mandate drives storage learning-by-doing
- RE learning-by-doing
- Mandate connects the two learning-by doing loops
- RE and system balancing

- Mandate impacts RE costs

- 配储要求引起干中学
- 可再生能源干中学
- 两个干中学回路图被配储政策连接
- 可再生能源与系统平衡

- 配储政策给可再生能源项目带来更多的投资成本

Dynamic story around new-type storage mandate
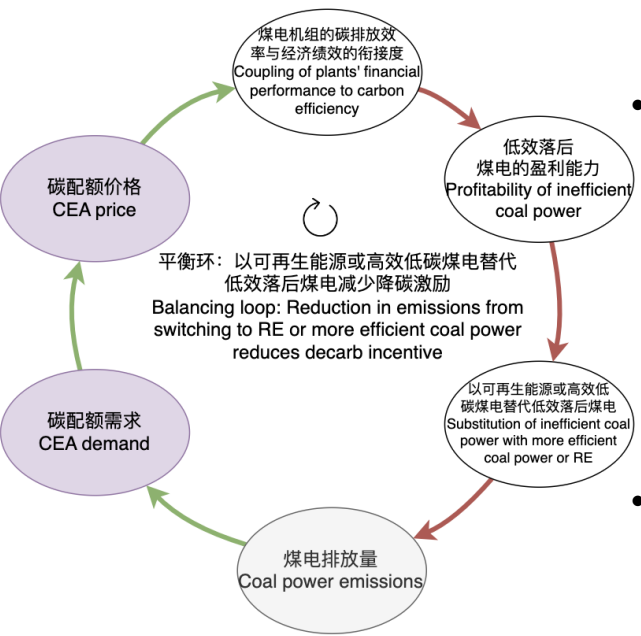## 配储政策的故事
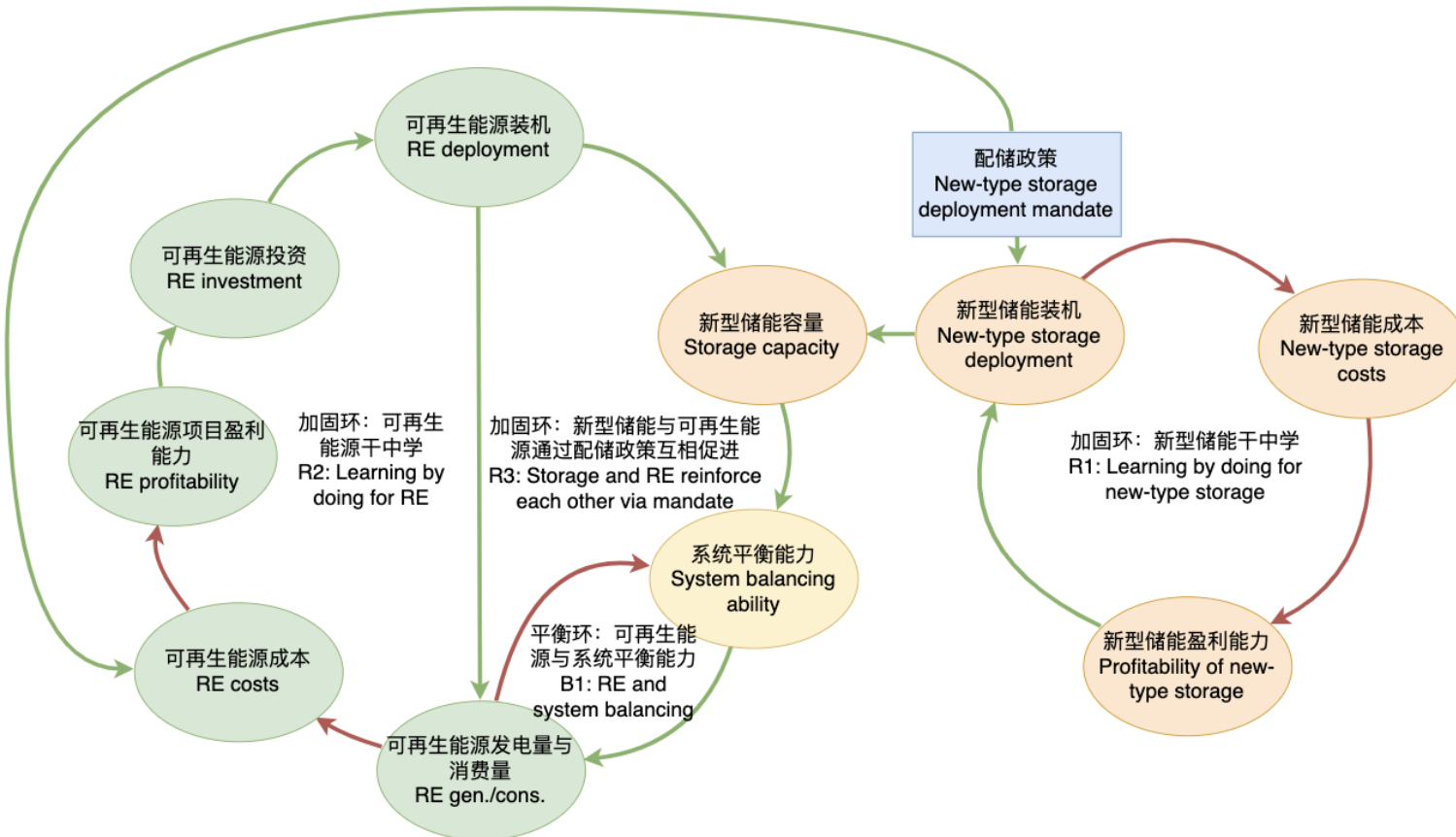
Questions

- What evidence do we have these loops are operating?

- What are their relative strengths?

- Despite the extra upfront costs, does this policy benefit RE in the long run?

讨论

- 有什么证据表明这些回路在循环？

- 回路的相对强度如何？

- 尽管在短期内会提高投资成本，配储政策有助于新能源的长期发展吗？

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Dynamic story around the ETS and coal
碳市场与煤电的故事

- Self-limiting dynamic

- Substitution for RE or efficient coal lowers subsequent CEA price pressure on coal

- Can be managed by floor price or supply of CEA

- 有自我限制现象

- 以可再生能源或高效低碳煤电替代低效落后煤电会减少碳价给煤电的去碳化压力

- 可以设置碳价下限或调整配额供应

- Self-amplifying dynamic

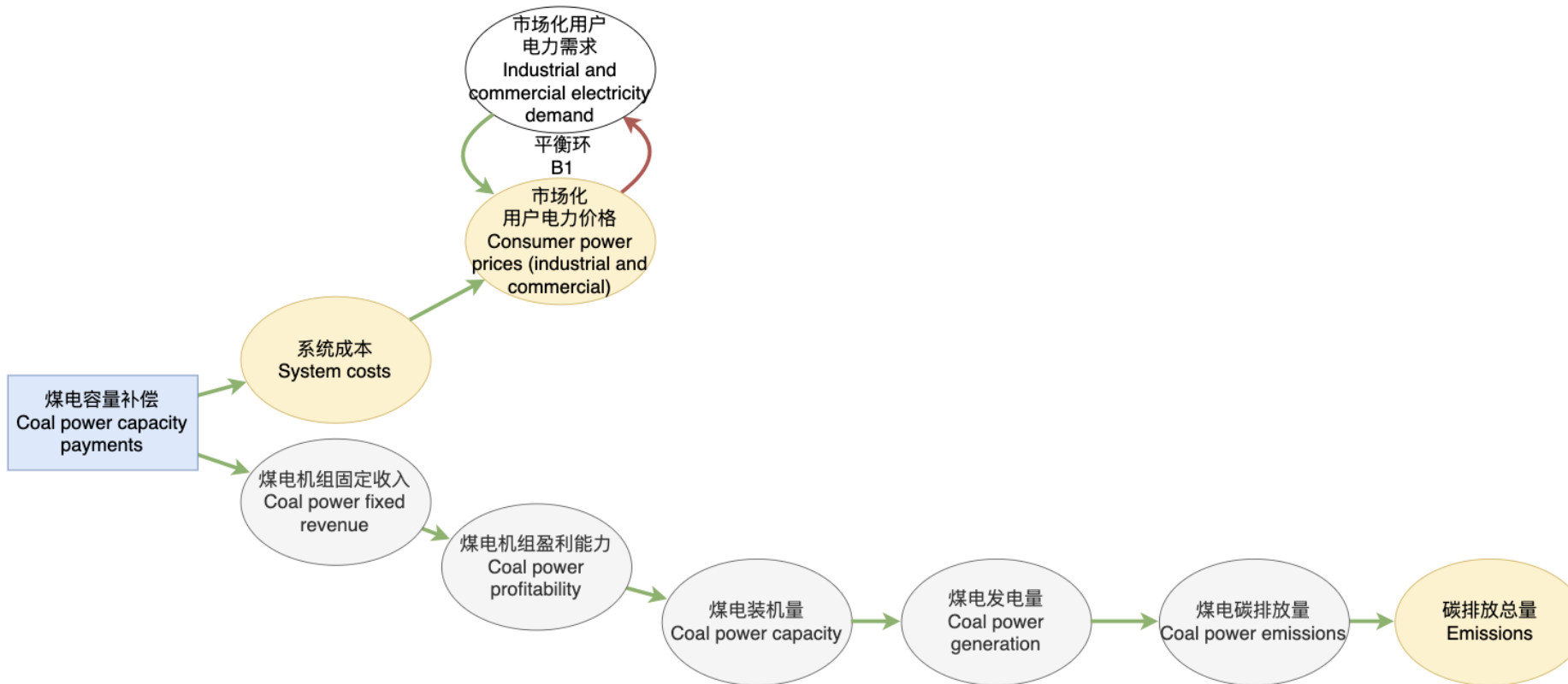- Lower generation lowers subsequent CEA supply

- 自我加固现象

- 煤电发电量下降使配额供应下降
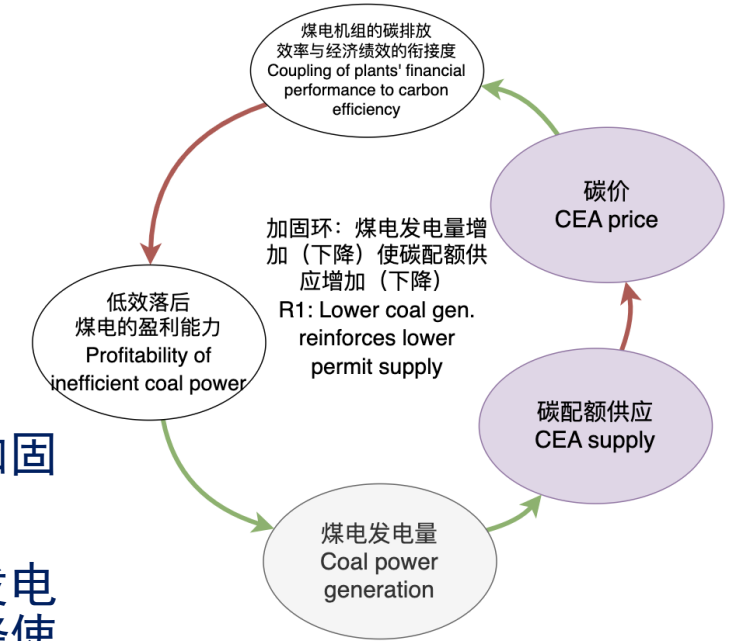
Downstream of coal capacity payments
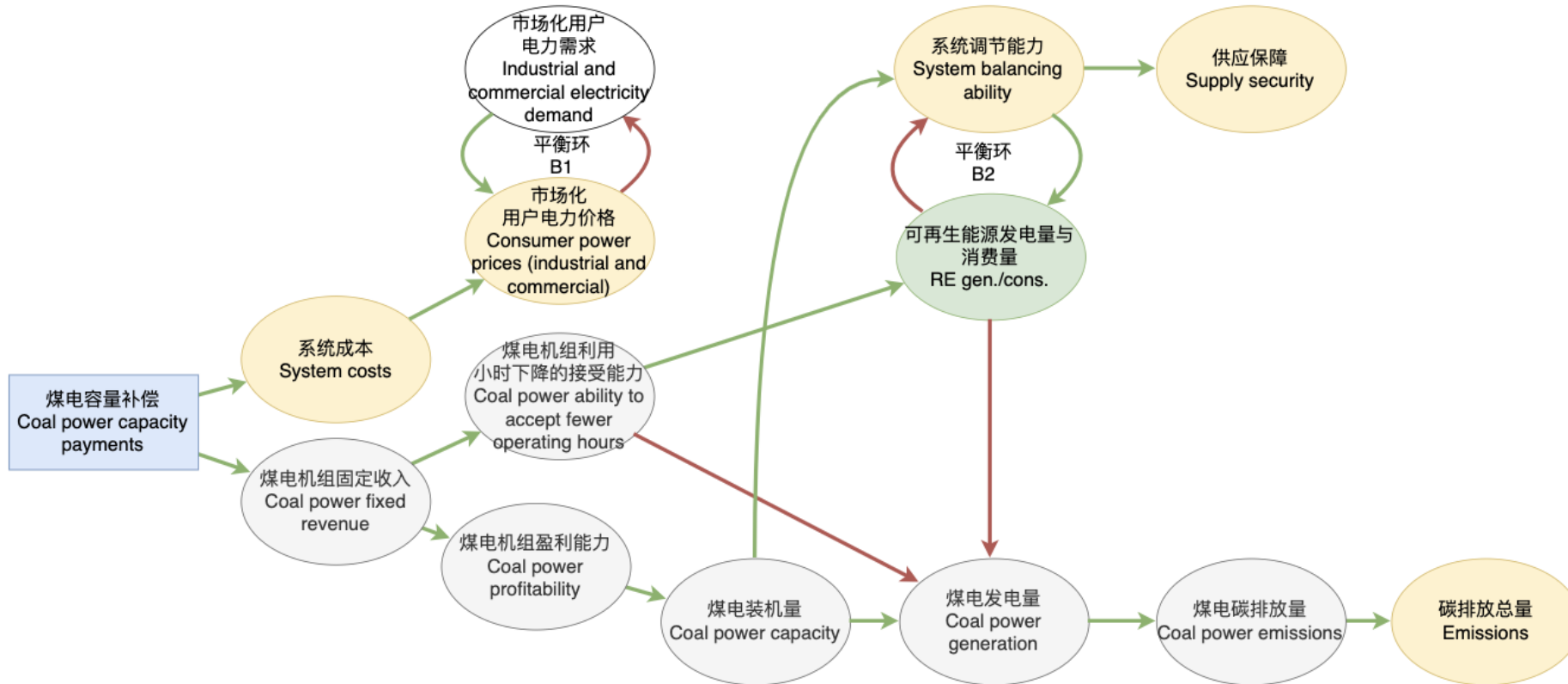# 煤电容量补偿的下游影响
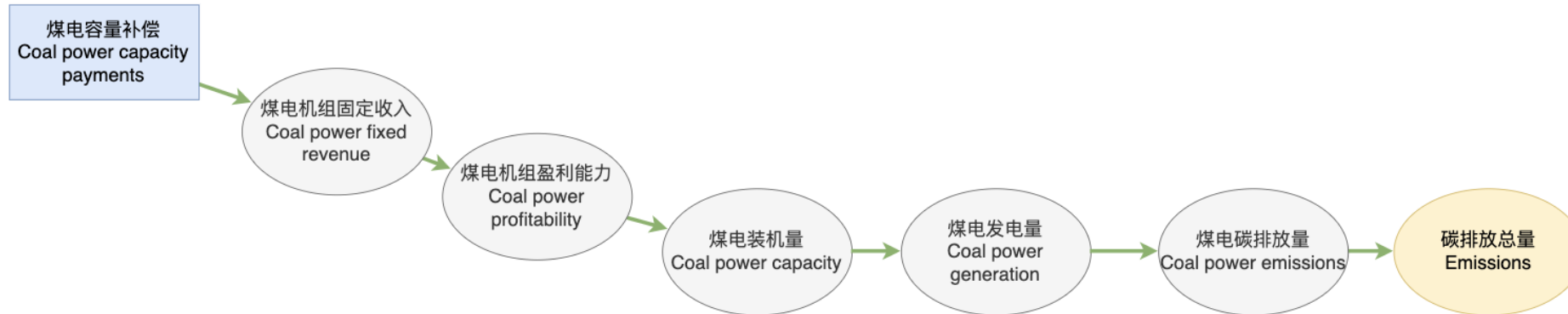
- Coal to emissions
- 补偿与碳排放的关系

Downstream of coal capacity payments
煤电容量补偿的下游影响

Downstream of coal capacity payments
煤电容量补偿的下游影响

- Coal to emissions
- 补偿与碳排放的关系
- System costs impacting demand
- 系统成本影响电力需求

- Fewer operating hours makes space for RE
- 煤电利用小时下降会为可再生能源腾出空间
- System balancing being pushed in both directions
- 对系统平衡的影响不清楚

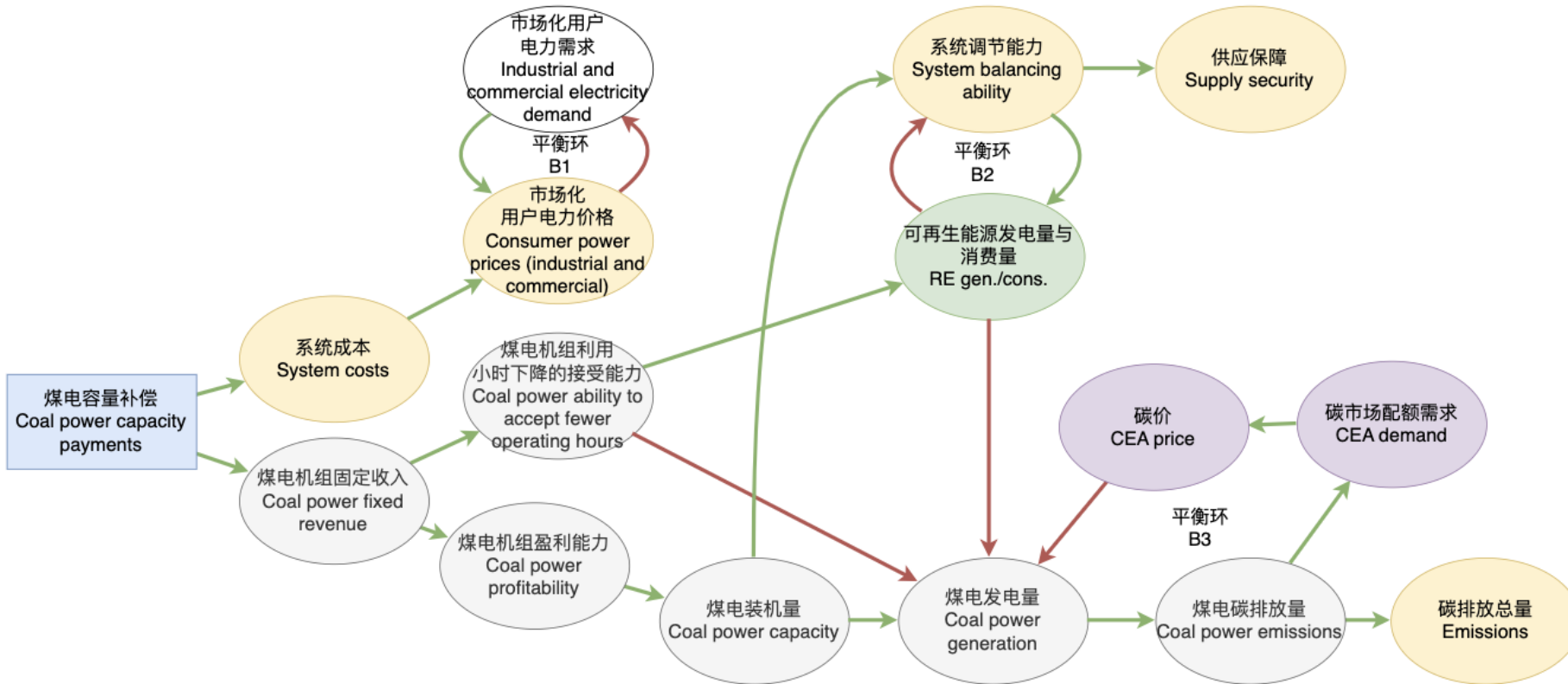ECONOMICS OF ENERGY INNOVATION AND SYSTEM TRANSITION

Downstream of coal capacity payments
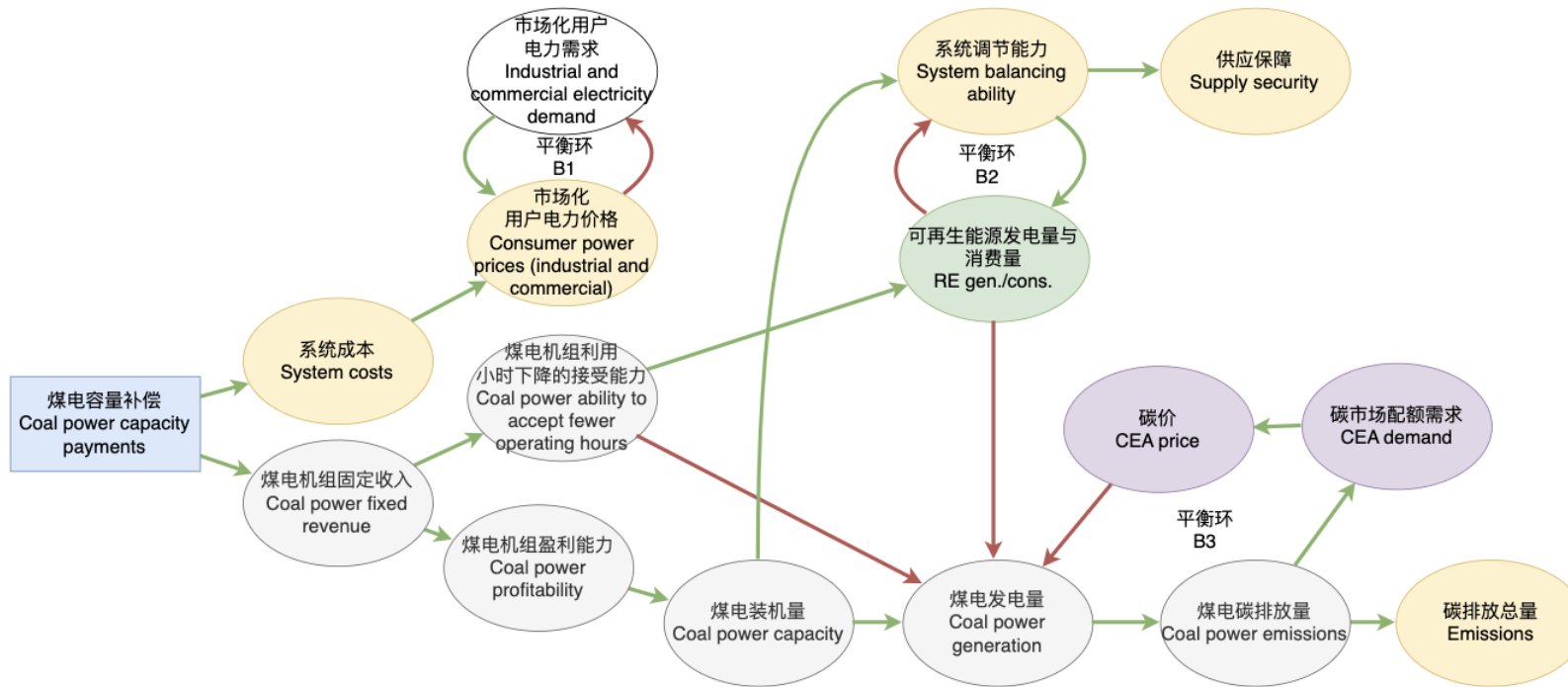# 煤电容量补偿的下游影响

- Coal to emissions
- 补偿与碳排放的关系
- System costs impacting demand
- 系统成本影响电力需求
- Fewer operating hours makes space for RE
- 煤电利用小时下降会为可再生能源腾出空间
- System balancing being pushed in both directions
- 对系统平衡的影响不清楚

- Balancing loop via CEA
- 由碳市场的平衡环
- Competing effects on emissions
- 对煤电、碳排放的影响不清楚

Downstream of coal capacity payments
煤电容量补偿的下游影响

Questions

- What evidence is there for the strengths of these different influences?

- How to cut out the direct path to emissions? (i.e. have payments improve flexibility of coal, but not profitability?)

讨论

- 有什么证据表明这些关系的相对强度？

- 如何可以切断政策增加排放的因果关系路？(比如，用补偿提高煤电的灵活性，而不增加煤电盈利？)

What next? 下一步

- Digest and incorporate discussion from today and this week
- Further sense checking of map and emerging findings
- Selection of key findings and narratives
- Gather evidence to complement narratives
- Range of outputs for different audiences

- 消化与合并今天与本周的讨论
- 继续审查和调整系统路与初步成果
- 抽出关键成果和故事
- 收集证据来补充故事
- 为不同的场景做出多种出品

Discussion / Q&A
讨论与问答

Project aim: to understand the interactions between technologies, policies, and markets, in the process of power sector reform

Questions:

- What should we focus on?
- What analysis should we do?
- What other sources of information could we use?
- What types of outputs and reports would be useful?

项目目的：了解技术、政策和市场之间在电力体制改革过程中的关系

问题：
- 我们该重点什么？
- 我们改进行什么样的分析？
- 我们可以用什么信息与数据？
- 什么样的出品与报告最有用？

Interactive session
参与性环节
1500-1730

Interactive systems mapping exercise
参与性系统图活动

- We will now break into three groups to do some focussed work with system maps
  - Security of supply (Pete and Da)
  - Energy costs and prices (Max and Liujun)
  - Decarbonisation (Simon and Songli)
- 我们现在分为三组参加专题系统图讨论
  - 保供 (Pete和张达)
  - 电力价格 (柯墨和六君)
  - 降碳 (Simon和松丽)

- Purpose
  - To hear your views on what affects these (sub)systems
  - We will build this into our analysis
  - To allow you to experience a systems mapping exercise first-hand
- 目的
  - 听听您对系统的因素和因果关系的意见
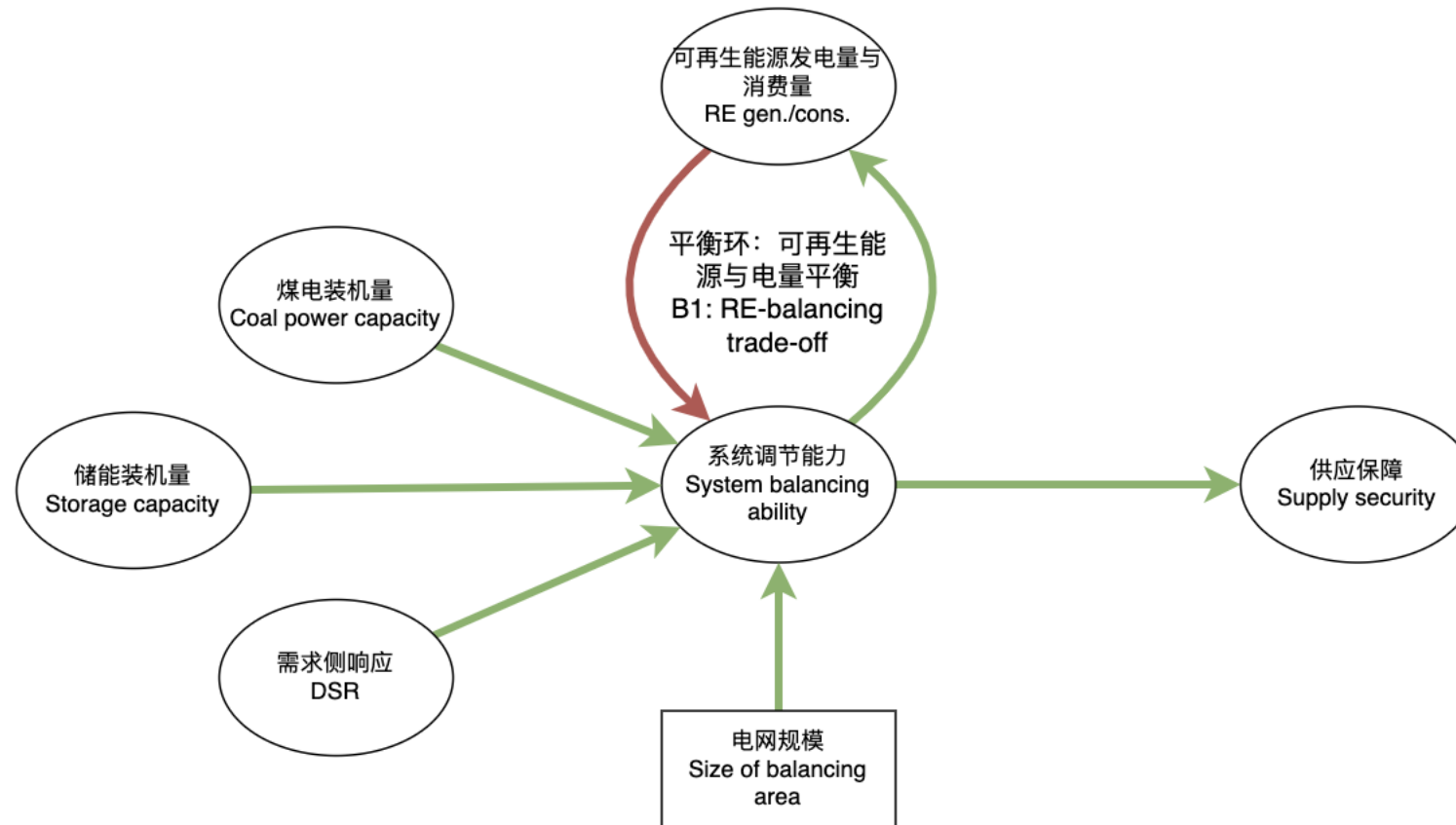 - 我们会把您的意见纳入分析
  - 让大家体验参与性系统图活动

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Interactive exercise 1500-1730
参与性系统图活动 1500-1730

- Instructions for your group
  - Review the small map you have been given
  - Discuss how you would like to extend and change it (your facilitators will help)
  - Make some changes
  - (If we have time) move around groups to see what others have done
  - Report back to whole group
- 指示
  - 审查你们的"种子图"
  - 商量你们想如何改变或者扩大（主持可以提供指导）
  - 调整系统图
  - (如果有时间的话) 到其他小组去看看他们的作品
  - 再聚集，跟大家分享意见

- Remember
  - Factors needs to be expressed as variables
  - Connections should be causal
  - Try to specify a real causal mechanism, not an idealised or very simple description
  - We should only include the most important aspects, not every plausible thing
  - If you can think of feedbacks that affect your group topic, please share them
- 请注意：
  - 因素必须以变量表达
  - 连线必须表示因果关系
  - 最好要指定真正的因果机制，而不包括理想化或者非常简单的关系
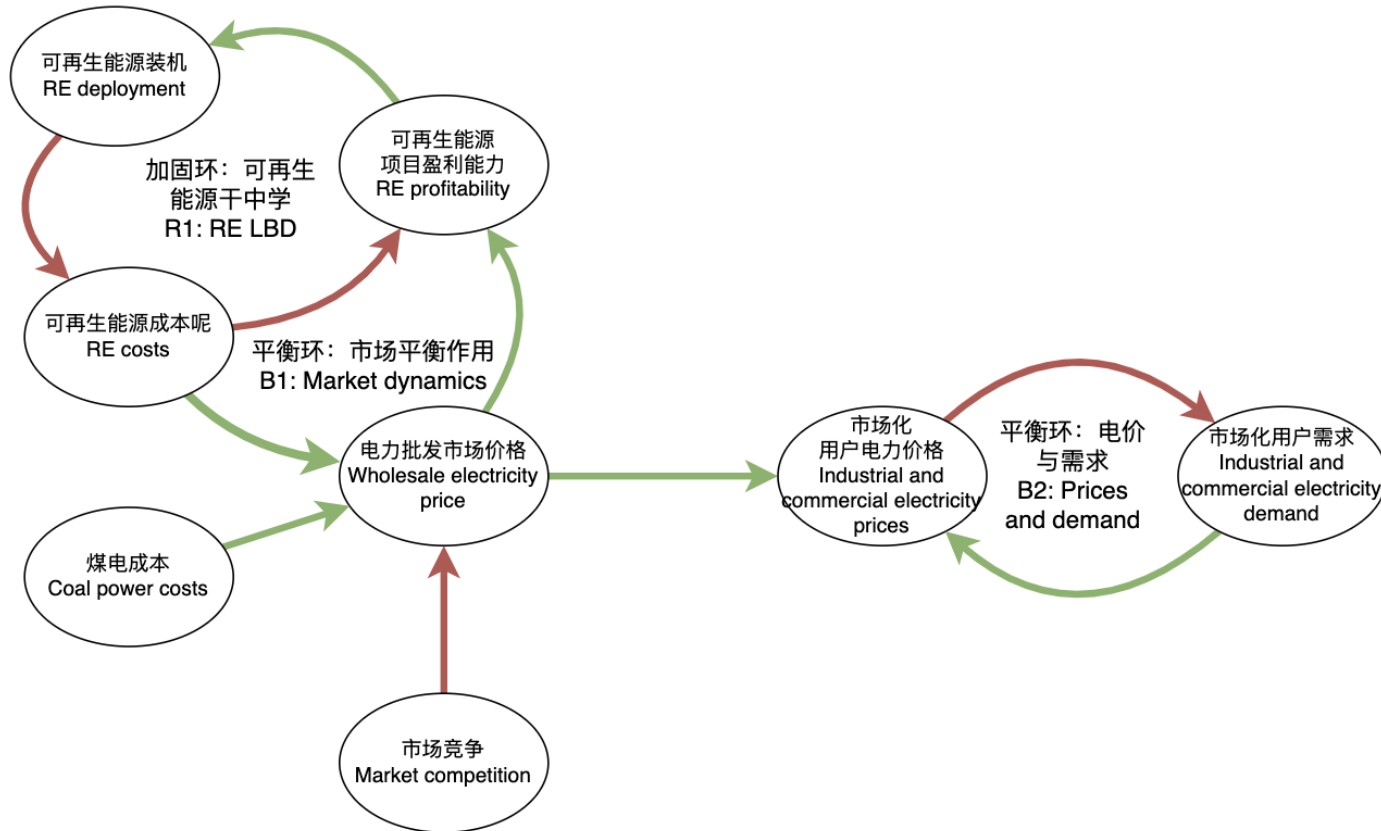 - 最好只包括最重要的机制，不必包括每个能想起的机制
  - 如果能想起什么因果回路循环，请跟大家分享

ECONOMICS OF ENERGY INNOVATION AND SYSTEM TRANSITION

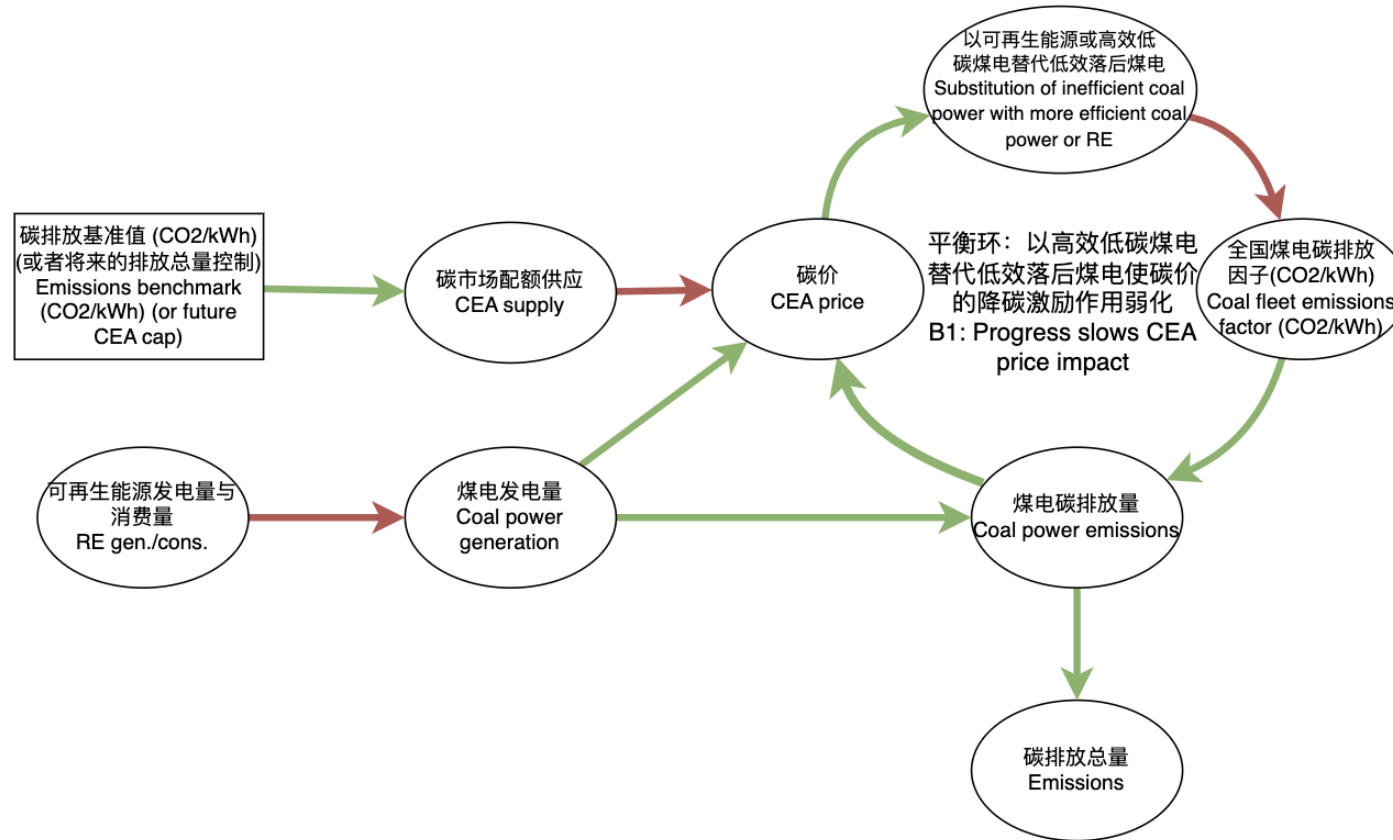# Seed map – security of supply
"种子图" – 保供

Seed map – energy costs and prices
"种子图" – 电力价格

Seed map – decarbonisation
"种子图" – 降碳

Interactive exercise 1500-1730
参与性系统图活动 1500-1730

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  - 如果能想起什么因果回路循环，请跟大家分享

ECONOMICS OF ENERGY INNOVATION AND SYSTEM TRANSITION

Interactive exercise – reflections
参与性系统图活动 – 反馈

- Any reflections from our facilitators?

- Reflections from whole group
  - What did you find interesting?
  - What was difficult?
  - Did it help you think differently about power sector reform and decarbonisation?
  - How do you think systems mapping could be used China, if at all?

- 主持们有什么反馈吗？

- 大家的反映
  - 哪些事让您感兴趣？
  - 那些事有点难？
  - 这个活动有没有让您在考虑电力体制改革采取新的思维方式？
  - 在您看来，如果可以的话，系统图如何在中国使用？