DRIVE

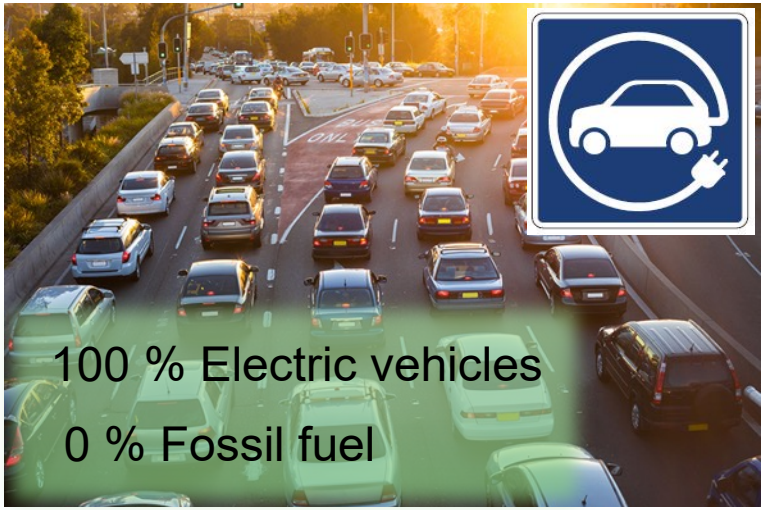
Green infrastructure

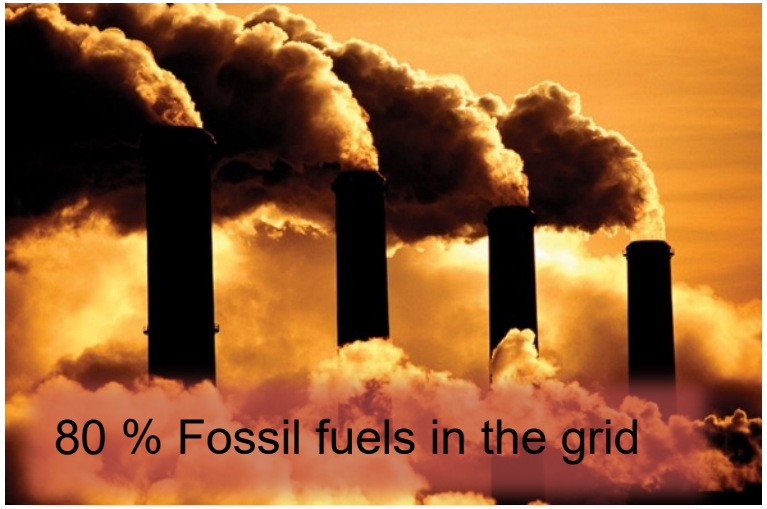
Renewable energy and storage to grid and electric vehicles

DRIVE

Challenge

Mittuniversitetet
MID SWEDEN UNIVERSITY





DRIVE

Challenge

100 % Electric cars

- ➢ Need for 300 000 battery packs per day

- High peak power demand for charging
  - Large power grid fluctuations
    - ➢ Need for grid power buffer

100 % Renewable energy

- ➢ Need massive growth of wind and solar power

- Large share of intermittent energy
  - Dependent on weather conditions
    - Power grid fluctuations
      - ➢ Additional need for grid power buffering

DRIVE

Sub-projects

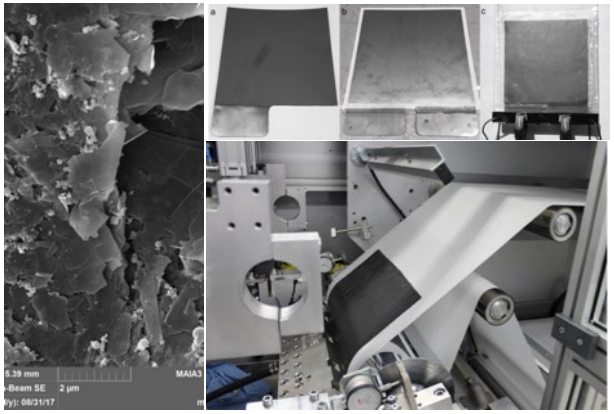
Mittuniversitetet
MID SWEDEN UNIVERSITY

Harvest

- Large-scale Nanogenerators
  - Noise-free wind power on buildings etc.
- Thermoelectric generators for winter use
  - Harvest energy from temperature differences

Store

- High capacity Lithium-ion batteries
  - Development of silicon-graphene
- Green low-cost supercapacitors
  - Water-based nanomaterial production and coating
- Green Aluminum-ion batteries
  - Development of low-cost, large-scale electrodes.

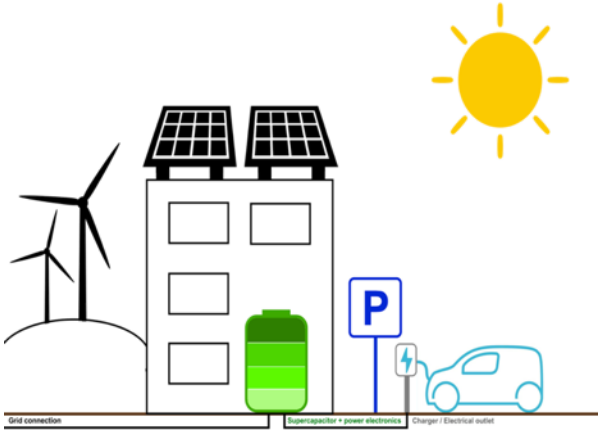


DRIVE

Sub-projects

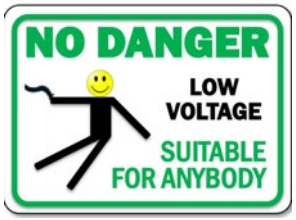
Charge

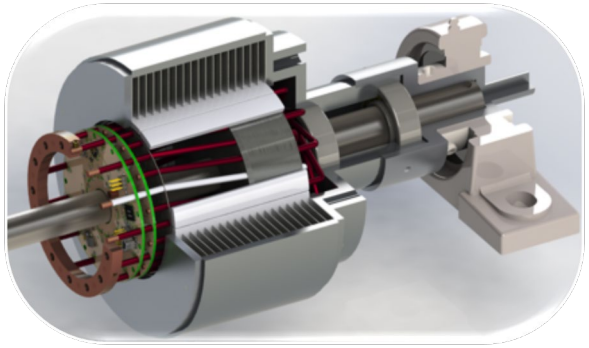
- Energy storage systems with power electronics
  - Fast charging from low-power grid connection
  - Buffer power peaks in grid and buildings
  - Bidirectional converters with high efficiency



Drive

- Efficient and safe low-voltage high power motors
  - Electric motors optimized for batteries
  - Low system voltage for high security
  - 30% lower energy losses



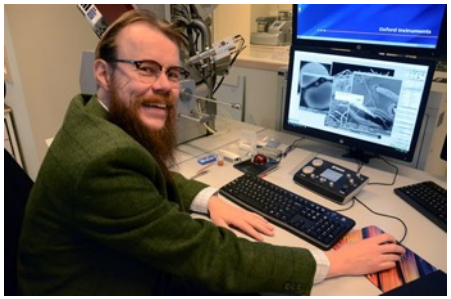


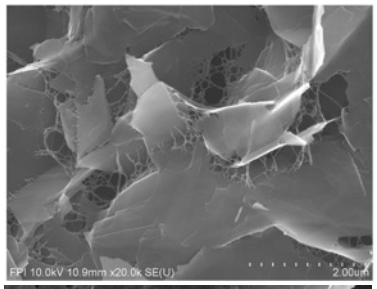
DRIVE

Sub-projects

MILAB

- MIUN Materials and Innovation Laboratory
  - Strengthen the material research at Mid Sweden University
  - Increase the material science competence in the region
  - Meet the material science needs





DRIVE

Green Energy - Vision

Mittuniversitetet
MID SWEDEN UNIVERSITY

Challange

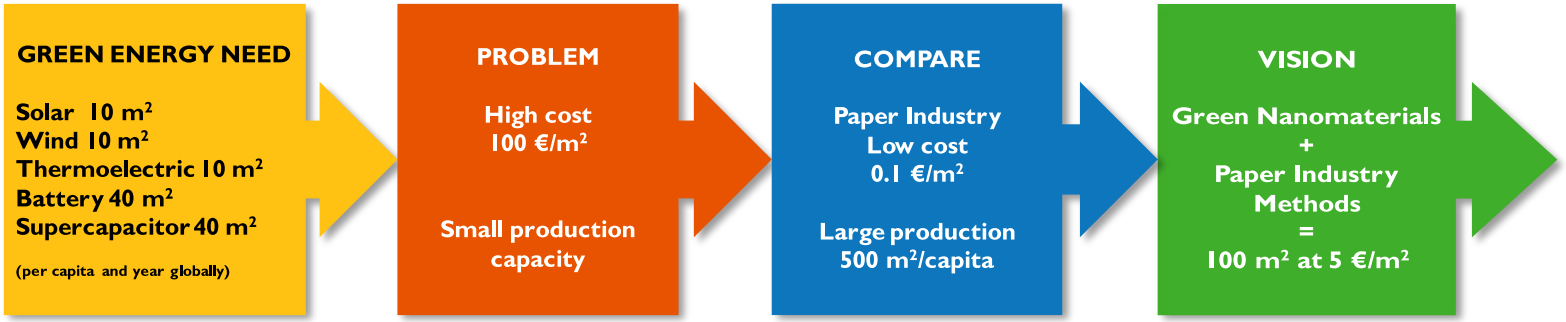
- Large need
- High cost

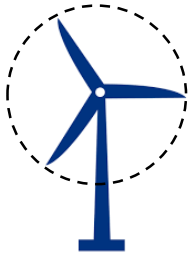
Possibility

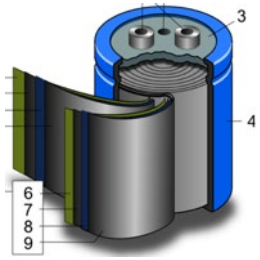
- Large-scale processes
- Green nanomaterials

Vision

- Low cost
- Environmentally friendly







Battery storage

- \+ High energy density (small unit)
- − Low power density and pulse-efficiency
- − Lifetime: 5-8 years, 10^3 charge cycles
- → Bulk energy storage

Supercapacitor storage

- − Low energy density (large unit)
- \+ High power density and pulse-efficiency
- \+ Lifetime: 15-20 years, 10^6 charge cycles
- → Quick power buffer

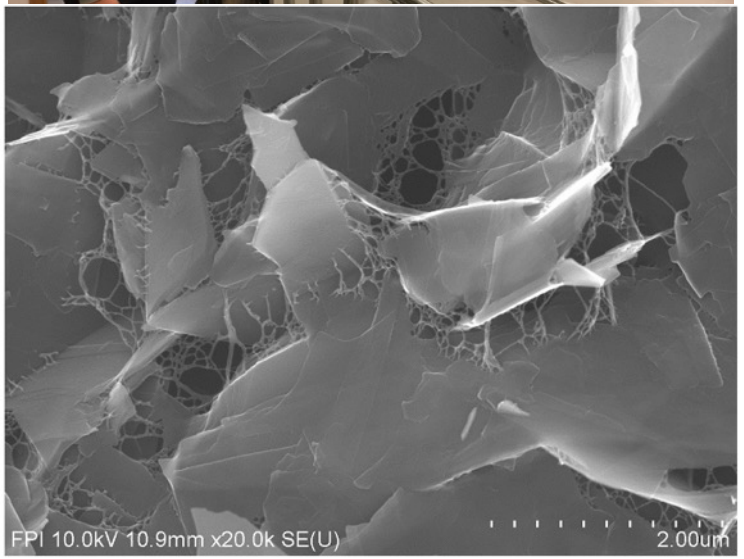
DRIVE

Developed processes - Materials

Mittuniversitetet
MID SWEDEN UNIVERSITY

- Large-scale graphene production
  - Mechanical exfoliation in water
  - Raw material: Graphite and water
  - Energy consumption: 10 kWh/kg
  - Lab production: 600 g/h

- Large-scale electrode production
  - Graphene-nanocellulose composite
  - High electrical conductivity
  - Large surface area
  - High ion permeability
  - Application
    - Supercapacitors
    - Batteries
    - Nanogenerators



DRIVE

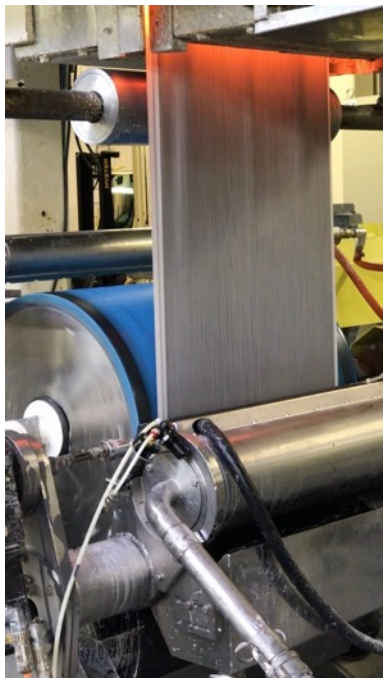
Developed processes – electrode coating

Mittuniversitetet
MID SWEDEN UNIVERSITY

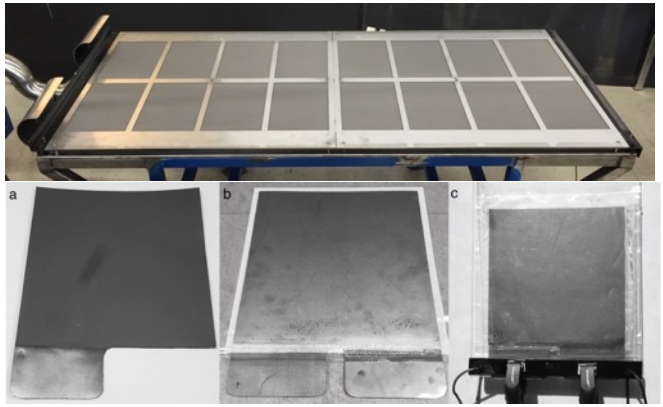
From lab-scale to industrial scale

- Electrode casting in lab: 2 m^2 per day
- Traditional electrode coating: 1 m^2 per minute
- Large-scale coating (pilot): 200 m^2 per minute
- Large-scale coating (full size): 2000 m^2 per minute

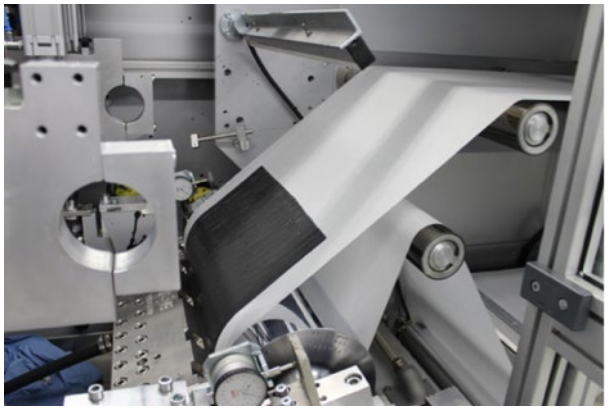
Recently succeded large-scale coating at UMV Sweden



Casting



Traditional electrode coater



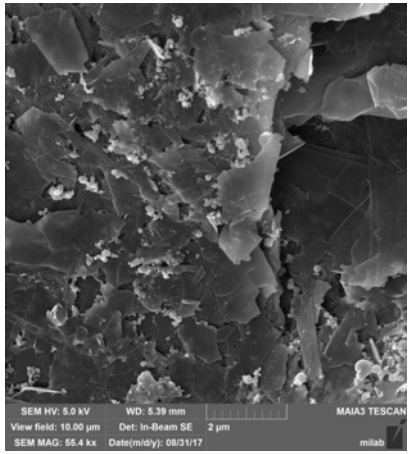
DRIVE

Energy storage – Status (lab)

Supercapacitors

- Suitable as power buffer
- Environmentally friendly materials
- Paper industry coating processes

➢ 90 % lower material costs
➢ 70 % performance (F/g)



Lithium-ion batteries

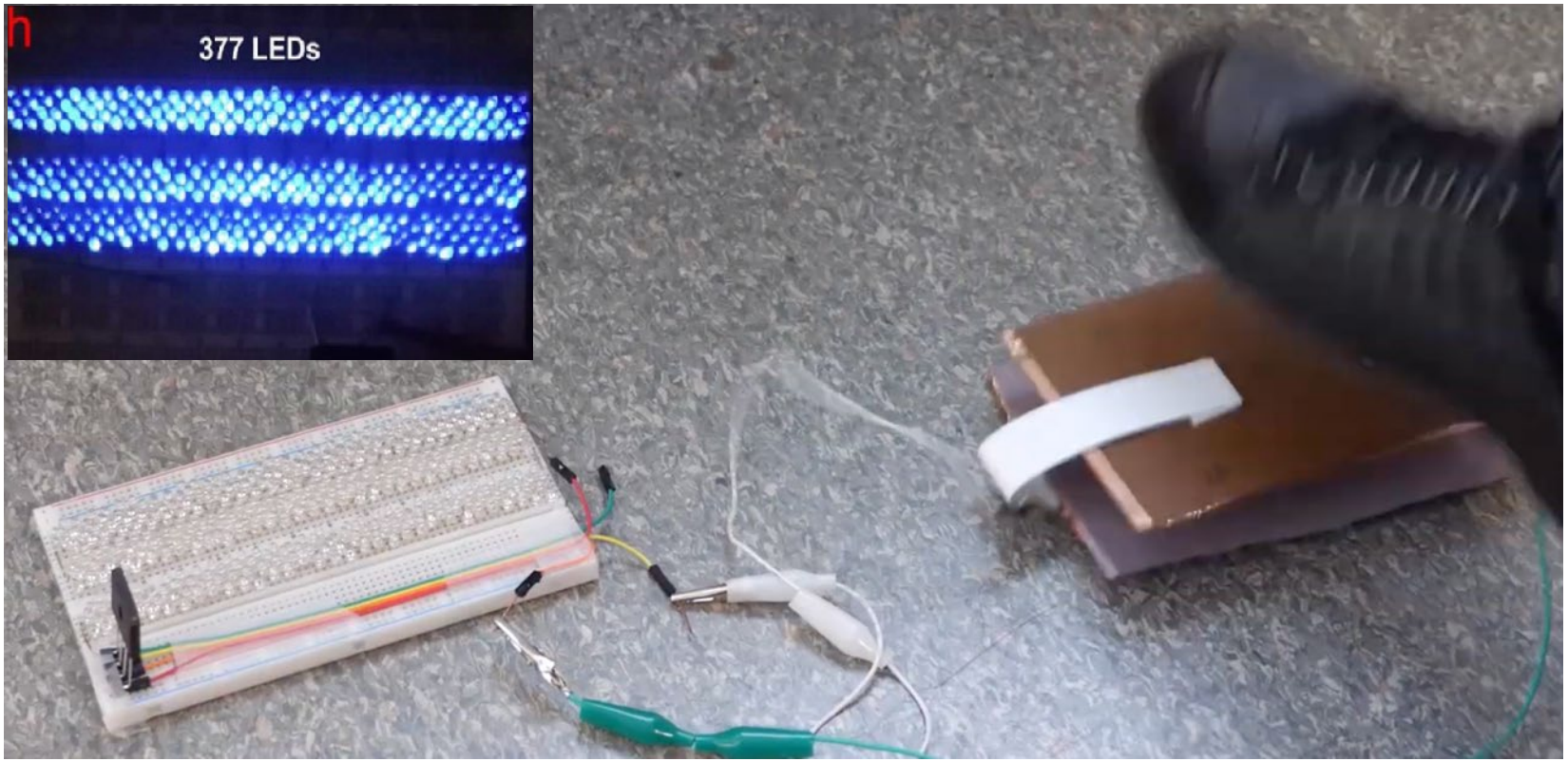
- Suitable for bulk energy storage
- Innovative low-cost materials
  - Silicon-graphene composites

➢ Low material cost
➢ 30 % higher anode storage capacity

Nanogenerators

Triboelectric nanogenerator – Proof of concept

- Cellulose-based active material and graphene current collectors



DRIVE

Green infrastructure

Renewable energy and storage to grid and electric vehicles